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Influence of Soil DNA Extraction Procedure to Assess Bacterial Diversity using Pyrosequencing of 16S rDNA

Sébastien Terrat, Richard Christen, Samuel Dequiedt, Christophe Mougel, Mélanie M. Lelievre, Pierre-Alain Maron, Pierre Plassart, Patrick Wincker, Corinne Cruaud, Claudy C. Jolivet, et al.

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Soil Interfaces in a Changing World

6th ISMOM

International Symposium of Interactions of Soil Minerals with
Organic Components and Microorganisms

3rd InterCongress of Commission 2.5 IUSS
Soil chemical, physical and biological interfacial reactions

Conference Proceedings

Book of Abstracts

26th June – 1st July 2011
Montpellier, France



INRA





In memoriam



13th September 2009

ISMOM 2011, the 6th ISMOM and 3rd InterCongress of IUSS 2.5 is dedicated to Professor Pan Ming HUANG who realized the importance of interdisciplinary studies and formed the working group that later evolved to become Commission 2.5, Soil chemical, physical and biological interfacial reactions. He organised the first ISMOM symposium in Edmonton, Canada in 1992 and was the driving force in the establishment of this now well recognised symposium series, with successful meetings in Nancy, France (1996), Naples, Italy (2000), Wuhan, China (2004) and Pucon, Chile (2007).

All your colleagues thank you for your tireless work for this scientific community.

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List of participants (name, electronic address, country)



The Organisation for the Prohibition of Chemical Weapons (OPCW) is the implementing body of the Chemical Weapons Convention.

- The OPCW is given the mandate to achieve the object and purpose of the Convention, to ensure the implementation of its provisions, including those for international verification of compliance with it, and to provide a forum for consultation and cooperation among States Parties. –

While the CWC seeks to ban chemical weapons, it also provides for international cooperation among States Parties in the pursuit of chemistry for peaceful purposes.

The Program GESSOL: A French Research Program on the environmental roles of soil

Soil was hitherto regarded as simply as a support for agricultural production. Now, it becomes clearer that soils as a natural resource perform a number of key environmental, social and economic functions. The Program GESSOL is based on the recognition of these roles. Its main aim is to provide scientific basis and the appropriate tools to decision makers and environmental managers to improve the consideration of the multifunctionality of soils and to reduce risks of degradation, particularly with respect to the draft of the European directive on soils.

GESSOL is an applied Research Program supported by the French Ministry for Ecology, Energy, Sustainable Development and Sea (MEEDDM). Since 1998, after three successive calls for proposals, the program financed 45 research projects. They addressed the most pressing requirements of decision makers and environmental managers concerning the environmental roles of soils, their sensitivity to degradation and the need for their protection. They also contributed to the installation of observation systems of soils and to the discussions about the European Strategy for Soil Protection.

The Research Program is administered by a Steering Committee which brings together various end-users, decision makers and managers concerned with soils. They define the research priorities in accordance with their perceived needs and concerns. A scientific advisory board is composed of specialists in various disciplines associated with soil. It elaborates calls for proposals based on the priorities established by the Steering Committee and guarantees the scientific excellence of the projects selected for funding and the results produced at the end of each project.

The last calls for proposals, published in 2008 and 2009, aimed to emphasize the many services rendered by soils because of the diversity of their functions, by associating researchers in social and human sciences. The Ministry pays particular attention to the dissemination of the research results to decision makers and managers. Conferences are regularly organized to encourage interaction and dialogue between researchers and end-users and a review of the research results, entitled "Gestion durable des sols"[1] (i.e., "Sustainable soils management"), was published in 2008 by Quae Editions.

[1] Citeau L., Bispo A., Bardy M., King D. coord. 2008. Gestion durable des sols. Editions Quae, Paris. 336 p

Coordinators:

Marion Bardy, Research
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Antonio Bispo and Thomas Eglin,
French Environment and Energy
Management Agency (ADEME)
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ISMOM 2011

Montpellier, France 26th June – 1st July

The aim of this symposium series is to create a forum for exchange and discussion between scientists from different fields of soil science: chemistry, biology, biochemistry, physics, ecology and environmental science. It is increasingly recognised that soil is a complex and spatially heterogeneous system composed of mineral, organic and biological components. Therefore multidisciplinary approaches are required to understand its functioning and to predict the dynamics of its capacity to sequester carbon, to protect the environment by immobilising pollutants and limiting erosion, to provide nutrients, water and physical support for living organisms, including agricultural and forestry production necessary for human survival and comfort. ISMOM will continue to foster cross fertilisation between discipline and multidisciplinary, and often international collaborations between colleagues.

ISMOM-2011, Soil Interfaces in a Changing World, follows successful 4-yearly meetings in Canada, France, Italy, China and Chile. There is a varied and exciting programme of oral and poster presentations with more than 250 registered participants from 30 countries from every continent. Poster sessions (one-day each) combine two or more scientific sessions.

The Welcome reception will be held in the Faculty of Medicine and all scientific sessions in the Faculty of Law, both historical buildings in the heart of Montpellier. Excursions to the surrounding countryside and picturesque villages and visits of Montpellier and the renowned Fabre art gallery will take place on Thursday 30th June after the Gala dinner in the Domaine de Verchant.

The scientific sessions are

1. Dynamics and stocks of C and N in soil
2. Advances in physical and biological techniques to study soil interfaces
3. Dynamics of pollutants in soil systems and bioremediation
4. Soil microbial activity and soil function
5. Organo-mineral interactions in soils

Keynote lectures will be given by Steve Banwart, Guy Kirk, W. Norde, Angela Sessitsch, Pascal Simonet, Don Sparks and Baoshan Xing. As for the participants, some are longstanding members of Commission 2.5 and others will discover ISMOM in Montpellier.

Special issues of the leading soil science journals, *European Journal of Soil Science* and *Soil Biology and Biochemistry* will be published. Calls for papers are already open and many scripts are already under review.

Generous sponsorship has allowed grants to be awarded to many participants, especially students and scientists from under-funded counties.

The conference will be followed by a scientific writing seminar on Friday 1st July chaired by Chris Anderson, CSIRO and *Soil Research*, Richard Burns, *Soil Biology and Biochemistry*, Steve Jarvis, *European Journal of Soil Science*.

The 7th ISMOM, and 4th InterCongress conference will be held in Ottawa, Canada in 2015 organised by Carlos Monreal.

International scientific committee

Jacques Berthelin, France
Richard Burns, Australia
Philip Brooks, UK
Claire Chenu, France
Danielle Fortin, Canada
Geoff Gadd, UK
Martin Gerzabek, Austria
Anna Gorbushina, Germany
Qiaoyun Huang, China
Ellen Kandeler, Germany
Ingrid Kogel-Knaber, Germany
Jon Lloyd, UK

María de la Luz Mora, Chile
Hervé Quiquampoix, France
Maria A. Rao, Italy
Lionel Ranjart, France
Nicola Senesi, Italy
Pascal Simonet, France
Siobhán Staunton, France
Carmen Trasar Cepeda, Spain
Antonio Violante, Italy
Kevin Wilkinson, Canada
Baoshan Xing, USA
Iain Young, Australia

National Organising committee

Siobhán Staunton
Jacques Berthelin
Michel Brossard
Tiphaine Chevallier
Jean-Luc Chotte
Claude Plassard
Hervé Quiquampoix

Webmaster: Sébastien Lamy
Administration: Corinne Allègre
Conference logistics : Adeline Ferreres

Programme Overview

Monday 27th June Tuesday 28th June Wednesday 29th June Friday 1st July

Opening ceremony Keynote + oral Keynote + oral Keynote + oral

Coffee break

Keynote + oral Oral Oral Oral

Lunch break

Keynote Keynote Keynote Keynote
Posters Posters Posters Oral
Closing ceremony

Coffee break

Oral Oral Oral Scientific writing
seminar

Welcome reception Sunday 26th June, Faculty of Medicine, 19 :00 – 23 :00

Gala dinner, Domaine de Verchant, Wednesday 29th June

Excursions, Thursday 29th June

Social programme, lunches and coffee included in registration fee.

Scientific programme (ISMOM, 26th June – 1st July 2011)

Monday 27th June

08:00 – 09:30 Registration

09:30 – 10:30 **Opening ceremony**

Tribute to the late Prof. Pan Ming Huang

10:30 – 11:00 Coffee break

11:00 – 11:30 **Keynote talk**

Prof Guy Kirk - Understanding changes in soil carbon stocks and global change

11:30 – 12:30 Oral session 1. Dynamics and stocks of C and N in soil

12:30 – 14:00 Buffet lunch

14:00- 14:30 **Keynote talk**

Prof. Donald Sparks – Analytical approaches for investigating reaction mechanisms at carbon/mineral and metal(loid)/mineral interfaces

14:30 – 16:00 Poster session I

16:00 – 16:30 Coffee break

16:30 – 18:30 Oral session 2. Advances in techniques to study soil interfaces

Tuesday 28th June

09:00 – 09:30 **Keynote talk**

Prof. Baoshan Xing - Environmental fate and toxicity of engineered nanoparticles

09:30 – 10:30 Oral session 3. Dynamics of pollutants in soil systems and bioremediation

10:30 – 11:00 Coffee break

11:00 – 12:40 Oral session 3. Dynamics of pollutants in soil systems and bioremediation (Part 2)

12:20 – 14:00 Buffet lunch

14:00- 14:30 **Keynote talk**

Prof Willem Norde - The influence of surface polymer coatings on adhesion of bacteria and biofilm formation

14:30 – 16:00 Poster session II

16:00 – 16:30 Coffee break

16:30 – 18:30 Oral session 2. Advances in techniques to study soil interfaces (Part 2)
1. Dynamics and stocks of C and N in soil (Part 2)

Wednesday 29th June

09:00 – 09:30 **Keynote talk**

Dr Steven Banwart - The Role of Soil Fungi in Biological Weathering and Soil Formation

09:30 – 10:30 Oral session 4. Soil microbial activity

10:30 – 11:00 Coffee break

11:00 – 12:40 Oral session 1. Dynamics and stocks of C and N in soil (Part 2)

12:20 – 14:00 Buffet lunch

14:00- 14:30 **Keynote talk**

Dr Angela Sessitsch - Plant-soil-microbe interactions: importance for plant performance, nutrient cycling and adaptation to environmental changes

14:30 – 16:00 Poster session III

16:00 – 16:30 Coffee break

16:30 – 18:10 Oral session 5. Organo-mineral interactions

Friday 1st July

09:00 – 09:30 **Keynote talk**

Dr Pascal Simonet – Is there a limit to the extent of the rare biosphere in soil ?

09:30 – 10:30 Oral session 4. Soil microbial activity (Part 2)

10:30 – 11:00 Coffee break

11:00 – 12:20 Oral session 4. Soil microbial activity

12:40 – 14:00 Buffet lunch

14:00 - 15:20 Oral session 4. Soil microbial activity

15:20 – 15:40 **Closing ceremony**

15:40 – 16:00 Coffee break

16:00 – 18:00 **Scientific Publishing workshop** chaired by

R. Burns (Editor in Chief, *Soil Biology & Biochemistry*)

S. Jarvis (Editor in Chief, *European Journal of Soil Science*)

C. Anderson (CSIRO, *Soil Research*)

Social Programme

Faculty of Medicine Sunday 26th June

Inscription 16 :00 – 20 :00

Welcome reception 19 :00 – 23 :00

Domaine de Verchant Wednesday 29th June

Gala Dinner, 19 15 – 23 :00

Buses departing from Montpellier at 19 :00

Excursions Thursday 30th June

1. Montpellier.

Walking tour of historical centre, followed by lunch in a typical brasserie and visit to the Musée Fabre

2. Clamouse & St Guilhem le Desert

(coach leaving Montpellier at 10 :00, returning 17 :00)

Visit of the Caves of Clamouse, lunch overlooking the Hérault Valley, guided tour of the medieval village of Saint Guilhem le Desert

3. St Jean de Fos & St Guilhem le Desert

(coach leaving Montpellier at 10 :00, returning 17 :00)

Visit of traditional poteries of St Jean de Fos, wine and local produce tasting, lunch at the historical Pont du Diable (Devil's Bridge) guided tour of the medieval village of Saint Guilhem le Desert

Full scientific programme (ISMOM, 26th June – 1st July 2011)

Monday 27th June

08:00 – 09:30 Registration

09:30 – 10:30 **Opening ceremony**

Tribute to the late Prof. Pan Ming Huang

10:30 – 11:00 Coffee break

11:00 – 11:30 **Keynote talk**

Guy Kirk - Understanding changes in soil carbon stocks and global change

11:30 – 12:30 **Oral session 1. Dynamics and stocks of C and N in soil**

11:30 Chandra Pandey Carbon stock in soils: effect of vegetation, soil type and climatic conditions on the western Himalaya, India

11:50 Robert Mills Global-scale topsoil carbon turnover depends upon vegetation type

12:10 Carlos Monreal The biological link to the chemistry of humification

12:30 – 14:00 Buffet lunch

14:00- 14:30 **Keynote talk**

Donald Sparks – Analytical approaches for investigating reaction mechanisms at carbon/mineral and metal(loid)/mineral interfaces

14:30 – 16:00 **Poster session I**

16:00 – 16:30 Coffee break

16:30 – 18:30 **Oral session 2. Advances in techniques to study soil interfaces**

16:30 Liesbeth Bouckaert Overcoming practical constraints in the application of X-ray CT to soil science

16:50 Carsten Mueller Soil interface composition at the submicron scale – applicability of NanoSIMS

17:10 Pascal Lienhard Near infrared reflectance spectroscopy and molecular tools to evaluate land use impact on soil characteristics and microbiota: a case study in a tropical ecosystem (altitude plains, Lao PDR)

17:30 Philippe Saliot Introduction to the NanoSIMS instrumentation in Soil science: quantitative mapping of soil-microbe-plant interactions and elemental fluxes with 50nm resolution

17:50 Ruth Ellerbrock Local-Scale Distribution of Organic Matter Composition and Wettability at Preferential Flow Path Surfaces

Tuesday 28th June

09:00 – 09:30 Keynote talk

Baoshan Xing - Environmental fate and toxicity of engineered nanoparticles

09:30 – 10:30 Oral session 3. Dynamics of pollutants in soil systems and bioremediation

- 09:30 Jianming Xu Environmental behavior of natural soil nanoparticles and their impact on the mobility of PAHs in soils
- 09:50 Peng Cai Interactions of pathogens *Escherichia coli* and *Streptococcus suis* with clay minerals
- 10:10 Richard Burns Microbes and Enzymes in Soil Bioremediation: Problems and Solutions

10:30 – 11:00 Coffee break

11:00 – 12:40 Oral session 3. Dynamics of pollutants in soil systems and bioremediation (Part 2)

- 11:00 Ellen Kandeler Bacterial and Fungal Contribution to the Degradation of MCPA at the Soil-Litter Interface
- 11:20 Patricia Garnier Modelling PAH dynamic during the remediation of contaminated soil through composting with organic wastes
- 11:40 Thomas Lerch Do bacterial-mineral interactions affect pesticide degradation? A case study with 2,4-D and *Cupriavidus necator* JMP134.
- 12:00 Rosalia Scelza Bioremediation of PCP contaminated soil by *Byssochlamys nivea* and *Scopulariopsis brumptii*

12:20 – 14:00 Buffet lunch

14:00- 14:30 Keynote talk

Willem Norde - The influence of surface polymer coatings on adhesion of bacteria and biofilm formation

14:30 – 16:00 Poster session II

16:00 – 16:30 Coffee break

16:30 – 18:30 Oral session 2. Advances in techniques to study soil interfaces (Part 2)

- 16:30 Cécile Monard Next generation sequencing to determine the shaping factors of microbial communities in environmental samples
- 16:50 Brian Kelleher CO₂ uptake by soil chemoautotrophs: identification, quantification and characterisation.
- 17:10 Sebastien TERRAT Influence of Soil DNA Extraction Procedure to Assess Bacterial Diversity using Pyrosequencing of 16S rDNA

16:30 – 18:30 Oral session 1. Dynamics and stocks of C and N in soil (Part 2)

- 17:30 Gerard Ros Unraveling the fate of dissolved organic N in soils using ¹⁵N tracing
- 17:50 Sean Case Biochar suppression of N₂O emissions from an agricultural soil
- 18:10 Jean-Philippe Bellenger Non symbiotic N₂ fixation; a misunderstood and underestimated N input?

Wednesday 29th June

09:00 – 09:30 Keynote talk

Steven Banwart - The Role of Soil Fungi in Biological Weathering and Soil Formation

09:30 – 10:30 Oral session 4. Soil microbial activity

09:30 Jacques Berthelin Diversity and interactions in bacterial communities involved in mineral weathering, iron mobility and ferrous toxicity in rice fields of tropical ferralsol-gleysol sequences.

09:50 Beat Frey Granite dissolving bacteria from the Damma glacier forefield

10:10 Christelle Collignon Seasonal dynamics of Al-bearing secondary minerals in an acidic forest soil: influence of Norway spruce roots

10:30 – 11:00 Coffee break

11:00 – 12:40 Oral session 1. Dynamics and stocks of C and N in soil (Part 3)

11:00 Fernando Moyano An Integrated Analysis of Soil Incubation Data: Deriving Soil Type Dependent Moisture-Respiration Relations

11:20 Christophe Moni Temperature effect on soil organic matter mineralization in arctic soils from Norway, Svalbard and Russia.

11:40 Heike Knicker Turnover of charcoal in fire-prone mineral soils of Southern Europe

12:00 Jean-Thomas Cornelis Charcoal production at mound kiln sites affects pedogenesis and soil capacity to stabilize organic carbon

12:20 Meriem Ben Sassi Heat waves and soil Mediterranean microbial communities: Differential influence of drought, high-temperature and perturbation duration

12:20 – 14:00 Buffet lunch

14:00- 14:30 Keynote talk

Angela Sessitsch - Plant-soil-microbe interactions: importance for plant performance, nutrient cycling and adaptation to environmental changes

14:30 – 16:00 Poster session III

16:00 – 16:30 Coffee break

16:30 – 18:10 Oral session 5. Organo-mineral interactions

16:30 Michaela Dippold Fate of functional groups of amino acids in soil assessed by position-specific labelling

16:50 Alexis DE JUNET Effect of hydrofluoric acid hydrolysis on organo-mineral complexes (Cambisol and Andosol, La Réunion Island)

17:10 Véronique Chaplain Influence of polymeric coating on particle adhesion measured by hydrodynamic detachment

17:30 Karin Eusterhues Reaction with ferrihydrite surfaces leads to fractionation and stabilization of soil organic matter

17:50 Thilo Rennert Geogenic CO₂ affects mineral and organic soil constituents on a mofette site

Friday 1st July

09:00 – 09:30 **Keynote talk**

Pascal Simonet – Is there a limit to the extent of the rare biosphere in soil ?

09:30 – 10:30 **Oral session 4. Soil microbial activity (Part 2)**

- 09:30 Dian Fiantis Bacterial action as an alteration agent of recent pyroclastic materials from Mt. Talang and Mt. Merapi, Indonesia
- 09:50 Mauricio Molina Effect of organic amendments and promoting bacteria on root density in table grape
- 10:10 Swartjes Frank Tiered approach to investigate the possibilities for growing crops for consumption on potentially contaminated land

10:30 – 11:00 Coffee break

11:00 – 12:20 **Oral session 4. Soil microbial activity**

- 11:00 Christine Knust Increasing demand for biomass energy: How does short rotation coppice impact soil properties in the medium and long-term? A case study in young soils in the Marchfeld, Lower Austria.
- 11:20 Qiaoyun Huang Impact of clay minerals and iron oxide on microbial diversity in two Chinese soils
- 11:40 Cristina Diez Effect of environmental conditions, soil type and ligninolytic substrate on biological activities in biomix of biobeds
- 12:00 Sara de Bolle Investigation of the P solubilising effect of phosphate solubilising bacteria **I**

12:20 – 14:00 Buffet lunch

14:00 - 15:20 **Oral session 4. Soil microbial activity**

- 14:00 Pil Joo Kim Effect of long-term fertilization on microbial community structure as a soil quality indicator in rice paddy soil
- 14:20 Alain Soler Influence of clay microstructure and organic matter on chlordecone sequestration in volcanic soils .
- 14:40 Aline Navel Control of copper impact on bacterial community by microscale localisation of microorganisms and added copper and organic matter in a vineyard loamy soil
- 15:00 Maria de la Luz Mora Effect of nitrogen and phosphorous fertilization on phosphatase and urease behavior in a Perennial Ryegrass rhizospheric soil

15:20 – 15:40 **Closing ceremony**

15:40 – 16:00 Coffee break

16:00 – 18:00 **Scientific Publishing workshop** chaired by

R. Burns (Editor in Chief, *Soil Biology & Biochemistry*)

S. Jarvis (Editor in Chief, *European Journal of Soil Science*)

C. Anderson (CSIRO, *Soil Research*)

Keynote presentations

The role of soil fungi in biological weathering and soil formation

Steven A. Banwart, A.Schmalenberger, A.L. Duran, M.E. Romero-Gonzales, J.R. Leake

Presenting author ; Steven Banwart, s.a.banwart@sheffield.ac.uk

Understanding changes in soil carbon stocks and global change

Guy Kirk

Presenting author : Guy Kirk, g.kirk@cranfield.ac.uk

The influence of surface polymer coatings on adhesion of bacteria and biofilm formation

Willem Norde

Presenting author: Willem Norde, willem.norde@wur.nl

Plant-soil-microbe interactions: importance for plant performance, nutrient cycling and adaptation to environmental changes

Angela Sessitsch, Stephane Compant, Birgit Mitter

Presenting author: Angela Sessitsch, angela.sessitsch@ait.ac.at

Is there a limit to the extent of the rare biosphere in soil?

Aurélie Faugier, Sébastien Cécillon, Davide Francioli, Tom Delmont, Emmanuel Prestat, Jean-Michel Monier, Maria-Teresa Ceccherini, Giacomo Pietramellara, Paolo Nannipieri and Pascal Simonet

Presenting author: Pascal Simonet, Pascal.Simonet@ec-lyon.fr

New Analytical Approaches for Investigating Reaction Mechanisms at Carbon/Mineral and Metal(loid)/Mineral Interfaces

Donald L. Sparks, Chunmei Chen, Peter Leinweber, Matt Ginder-Vogel, and Gautier Landrot

Presenting author: Donald Sparks, dlsparks@udel.edu

Environmental Fate and Toxicity of Engineered Nanoparticles

Baoshan Xing

Presenting author: Baoshan Xing, bx@pssci.umass.edu

Oral Presentations

by order in Programme

Carbon stock in soils: effect of vegetation, soil type and climatic conditions on the western Himalaya, India

C.B. Pandey, S.K. Singh, G.S. Siddhu, Dipak Sarkar

Presenting author: Chandra Pandey, cbpandey5@rediffmail.com

Global-scale topsoil carbon turnover depends upon vegetation type

Robert Mills, Edward Tipping

Presenting author: Robert Mills, romi@ceh.ac.uk

The biological link to the chemistry of humification

C.M. Monreal and M. Schnitzer

Presenting author: Carlos Monreal, Carlos.Monreal@AGR.GC.CA

Overcoming practical constraints in the application of X-ray CT to soil science

Liesbeth Bouckaert, Steven Sleutel, Denis Van Loo, Veerle Cnudde, Manuel Dierick, Patric Jacobs, Luc Van Hoorebeke, Stefaan De Neve

Presenting author: Liesbeth Bouckaert, Liesbeth.Bouckaert@ugent.be

Soil interface composition at the submicron scale – applicability of NanoSIMS

Carsten W. Mueller, Carmen Höschen, Hans Lugmeier, Katja Heister, Ingrid Koegel-Knabner

Presenting author: Carsten Mueller, carsten.mueller@wzw.tum.de

Near infrared reflectance spectroscopy and molecular tools to evaluate land use impact on soil characteristics and microbiota: a case study in a tropical ecosystem (altitude plains, Lao PDR)

Pascal Lienhard, Richard Joffre, Pierre-Alain Maron, Florent Tivet, Lucien Séguy, André Chabanne, Jean Claude Legoupil, Sengphanh Sayphoummie, Bounma Leudphanane, Virginie Nowak, Tiffanie Régnier, Mélanie Lelièvre, Samuel Dequiedt, Lionel Ranjard

Presenting author: Pascal Lienhard, pascal.lienhard@cirad.fr

Introduction to the NanoSIMS instrumentation in Soil science: quantitative mapping of soil-microbe-plant interactions and elemental fluxes with 50nm resolution

Philippe Saliot, Camescasse Emmanuel, Hillion François, Horréard François

Presenting author: Philippe Saliot, horreard@cameca.com

Local-Scale Distribution of Organic Matter Composition and Wettability at Preferential Flow Path Surfaces

Ruth H. Ellerbrock, Horst H. Gerke, Martin Leue

Presenting author: Ruth Ellerbrock, ellerbrock@zalf.de

Environmental behavior of natural soil nanoparticles and their impact on the mobility of PAHs in soils

Xu Jianming, Li Wenyan

Presenting author: Jianming Xu, jmxu@zju.edu.cn

Interactions of pathogens Escherichia coli and Streptococcus suis with clay minerals

Peng Cai

Presenting author: Peng Cai, cp@mail.hzau.edu.cn

Microbes and Enzymes in Soil Bioremediation Problems and Solutions

Richard Burns

Presenting author: Richard Burns, r.burns@uq.edu.au

Bacterial and Fungal Contribution to the Degradation of MCPA at the Soil-Litter Interface

Ellen Kandeler, Holgel Pagel, Markus Schröder, Walter Vetter, Fabrice Martin-Laurent, Thilo Streck, Christian Poll

Presenting author: Ellen Kandeler, Ellen.Kandeler@uni-hohenheim.de

Modelling PAH dynamic during the remediation of contaminated soil through composting with organic wastes

Yuan Zhang, Patricia Garnier, Yongguan Zhu, Houot Sabine

Presenting author: Patricia Garnier, pgarnier@grignon.inra.fr

Do bacterial-mineral interactions affect pesticide degradation ? A case study with 2,4-D and Cupriavidus necator JMP134.

Thomas Lerch, Claire Chenu, Marie-France Dignac, Enrique Barriuso

Presenting author: Thomas Lerch, thomas.lerch@u-pec.fr

Bioremediation of PCP contaminated soil by Byssoschlamys nivea and Scopulariopsis brumptii

Luciano Bosso, Nejla Hechmi, Rosalia Scelza, Antonino Testa, Gennaro Cristinzio, Maria A. Rao

Presenting author: Rosalia Scelza, rosalia.scelza@unina.it

Next generation sequencing to determine the shaping factors of microbial communities in environmental samples

Cécile Monard

Presenting author: Cécile Monard, cecilemonard@yahoo.fr

CO₂ uptake by soil chemoautotrophs identification, quantification and characterisation.

Brian Kelleher

Presenting author: Brian Kelleher, brian.kelleher@dcu.ie

Influence of Soil DNA Extraction Procedure to Assess Bacterial Diversity using Pyrosequencing of 16S rDNA

Sebastien Terrat, Richard Christen, Samuel Dequiedt, Christophe Mougel, Mélanie Lelievre, Pierre-Alain Maron, Pierre Plassart, Patrick Wincker, Corinne Cruaud, Claudy Jolivet, Dominique Arrouays, Antonio Bispo, Philippe Lemanceau, Lionel Ranjard

Presenting author: Sebastien Terrat, sebastien.terrat@dijon.inra.fr

Unraveling the fate of dissolved organic N in soils using ¹⁵N tracing

Gerard H. Ros, Willem H. Van Riemsdijk

Presenting author: Gerard Ros, gerard.ros@wur.nl

Biochar suppression of N₂O emissions from an agricultural soil

Sean Case, Jeanette Whitaker, Niall McNamara, David Reay

Presenting author: Sean Case, secase@ceh.ac.uk

Non symbiotic N₂ fixation; a misunderstood and underestimated N input?

Jean-Philippe S Bellenger, Thomas Wichard, Yan Xu, Anne ML Kraepiel

Presenting author: Jean-Philippe Bellenger, jean-philippe.bellenger@usherbrooke.ca

Diversity and interactions in bacterial communities involved in mineral weathering, iron mobility and ferrous toxicity in rice fields of tropical ferralsol-gleysol sequences.

Jeanne Bongoua, Aurélie Cebron, Gballou Yoro, Albert Yao-Kouamé, Christian Mustin, Jacques Berthelin

Presenting author: Jacques Berthelin, jacques.berthelin@limos.uhp-nancy.fr

Granite dissolving bacteria from the Damma glacier forefield

Beat Frey, Stephan Rieder, Ivano Brunner, Michael Ploetze, Helmut Brandl, Gerhard Furrer

Presenting author: Beat Frey, beat.frey@wsl.ch

Seasonal dynamics of Al-bearing secondary minerals in an acidic forest soil: influence of Norway spruce roots

Christelle Collignon, Marie-Pierre Turpault

Presenting author: Christelle Collignon, christelle.collignon@nancy.inra.fr

An Integrated Analysis of Soil Incubation Data: Deriving Soil Type Dependent Moisture-Respiration Relations

Fernando Moyano, Claire Chenu, Nadezda Vasilyeva

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Temperature effect on soil organic matter mineralization in arctic soils from Norway, Svalbard and Russia.

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Turnover of charcoal in fire-prone mineral soils of Southern Europe

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Charcoal production at mound kiln sites affects pedogenesis and soil capacity to stabilize organic carbon

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Heat waves and soil Mediterranean microbial communities Differential influence of drought, high-temperature and perturbation duration

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Fate of functional groups of amino acids in soil assessed by position-specific labelling

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Effect of hydrofluoric acid hydrolysis on organo-mineral complexes (Cambisol and Andosol, La Réunion Island)

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Influence of polymeric coating on particle adhesion measured by hydrodynamic detachment

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Reaction with ferrihydrite surfaces leads to fractionation and stabilization of soil organic matter

Karin Eusterhues, Julia Neidhardt, Thilo Rennert, Anke Hädrich, Kirsten Küsel, Ingrid Kögel-Knabner, Udo Schwertmann, Kai Uwe Totsche

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Geogenic CO₂ affects mineral and organic soil constituents on a mofette site

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Bacterial action as an alteration agent of recent pyroclastic materials from Mt. Talang and Mt. Merapi, Indonesia

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Effect of organic amendments and promoting bacteria on root density in table grape

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Tiered approach to investigate the possibilities for growing crops for consumption on potentially contaminated land

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Increasing demand for biomass energy How does short rotation coppice impact soil properties in the medium and long-term? A case study in young soils in the Marchfeld, Lower Austria.

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Impact of clay minerals and iron oxide on microbial diversity in two Chinese soils

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Effect of environmental conditions, soil type and ligninolytic substrate on biological activities in biomix of biobeds

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Investigation of the P solubilising effect of phosphate solubilising bacteria

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Effect of long-term fertilization on microbial community structure as a soil quality indicator in rice paddy soil

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Influence of clay microstructure and organic matter on chlordecone sequestration in volcanic soils .

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Control of copper impact on bacterial community by microscale localisation of microorganisms and added copper and organic matter in a vineyard loamy soil

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Effect of nitrogen and phosphorous fertilization on phosphatase and urease behavior in a Perennial Ryegrass rhizospheric soil

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Poster Presentations

alphabetical order of presenting author

A, B, C

Influence of montmorillonite on the catalytic activity of chymotrypsin: effect of enzyme and substrate adsorption

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Effect of selenium seed ptization on rhizobacteria associated with cereal crops grown in an Andisol

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Integrated use of arbuscular mycorrhiza fungi and fertiliser: effects on soil clay assemblage

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Extraction of low molecular organic acids and siderophores from soil analysed by liquid chromatography mass spectrometry

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Influence of silvicultural treatments on the soil properties in burned and unburned Mediterranean forests

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Soil properties of Mediterranean agricultural areas under fast-growing Paulownia (*Paulownia elongata* x *fortunei*) plantations

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Struvite formation by soil bacteria. Is the struvite a metaestable mineral in the phosphorous cycle in soils?

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Mangrove soil of the Graciosa River, in Bahia, Brazil: the microbial approaches

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Interannual variation of SOC fractions in volcanic soils (Canary Islands, Spain)

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Linking Genomic Structure to Function in Soil Aggregates

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Mineralogical effect of FAO particle size analysis procedure

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Iron oxide removal and copper sorption on a Luvisol argic horizon

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Does clay mineralogy influence aggregation formation and stability? Insights from fractionation analyses conducted on soils under different land-uses.

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Water infiltration rate an indicator of physical quality recovery of an Oxisol

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Nitrate leaching loss under crop-livestock systems in the Cerrado region, Brazil

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Bacillus cereus, a model for studying the impact of climate changes on food borne pathogens in soils? Preliminary experiments

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Soil humidity, soil depth and density of plantation influence catabolic structure of microbial communities in maize crop system

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Phosphorus uptake and phosphatase activity under different phosphorus and nitrogen fertilization of Chilean Andisol pastures

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Phytate-induced selection of rhizobacterial community present in pastures from volcanic soils

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Phytase interaction with allophane and iron oxide coated allophane nanoclays

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Effect of oxalic and citric acid on adsorption of copper and cadmium onto vermiculite, kaolinite and goethite.

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Assessing litter quality by ¹³C-CPMAS NMR predicts decay rate better than C/N and Lignin/N ratios

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SOMDY: a new model of carbon sequestration based on C chemical quality by ¹³C CPMAS NMR and physical aggregation of organic matter

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Characterizing organo-mineral complexes in surface and subsurface horizons of an acid loamy soil using sequential density fractionation

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Influence of rice residues management on the soil and water biogeochemistry

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Do feeding on soil increases N₂O emission ?

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Total soil carbon stocks in Burkina Faso: survey and behavior
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The potential of NIR spectroscopy to predict the soil texture and mineralogy in the Cerrado Latosols

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High mountain environments in Patagonia Argentina: analysis of relations between plants, intraradical fungi and soil characteristics.

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Evaluation of nanoclays in acid phosphatase immobilization to increase the phosphorus availability in soils

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Effect on the total and functional bacterial community in amended soils with olive oil waste

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Combined effects of nitrogen and sulfur fertilization on selenium accumulation and antioxidant capacity in ryegrass plants.

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Response of soil microbial biomass to CeO₂ nanoparticles

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Relative contributions of organic and inorganic carbon in the CO₂ emitted from a Tunisian calcareous agricultural soil: Effect of increasing temperatures

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The influence of the interaction of treated sewage effluent and compost on the dynamics of the nitrogen in the soil

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Description the soil buffering disturbance in pesticides polluted soils

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D,E,F

Molecular characterization of hydrophobic coatings and fixed lipids from extremely water repellent pine and eucalypt forest soils.

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Adsorption of methylene blue by different low cost materials for practical classes of environmental chemistry

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Cationic clays on human health: an overview

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Adsorption of several contaminants by natural and modified clays as a sustainable application

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Microbial communities in vineyard soils with changing land use: effect of Cu accumulation and soil pH.

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Degradation of chlorpyrifos by actinomycetes isolated from soil

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Nodulation and growth of common bean (*Phaseolus vulgaris*) in multi-local field tests of organic horticulture in Hérault valley links with phosphorus bio-availability.

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Coupled transport of humic acids and copper through saturated porous media

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Role of carbonates and clay minerals in macroaggregates dynamics and organic matter stabilization in semi-arid Mediterranean soils

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Protein-driven desorption curves of soil enzymes

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Molecular identification of fungi isolated from municipal sewage sludge

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Phosphorus removal by using mineral soils from the Antofagasta region in the north of Chile

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Biodegradation of low molecular weight organic acids in rhizosphere soils under tropical montane rain forest

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Heavy metals removal from water using aquatic plants (*Nasturtium officinale* and *Mimulus glaberrimus*)

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G,H,I

Polycyclic Aromatic Hydrocarbons in the atmospheric precipitation–soil–lismetric waters system of technogenic landscapes

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Effect of successive application of pulp mill sludge to degraded chilean volcanic soil: A columns leaching study

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Synthesis and characterization of spermine-exchanged montmorillonite and its complexes with the herbicide fluometuron

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Changes in the Microbial Community of a Semi-arid Degraded Soil after the Addition High Amounts of Organic Urban Wastes

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Evaluation of the Suitability of Using High Amounts of Urban Wastes for Degraded Arid Soils Restoration and C Fixation

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Modifications of some soil organic matter fractions in surface horizons of maize soils afforested with different tree species

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Influence of stand quality on soil properties in thermophilic Spanish juniper woodlands (*Juniperus thurifera* L.) in South-Eastern Spain

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Visualisation and modelling of water-air interface in soil porosity: impact on microbial degradation

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Synthetic allophane nanoparticles coated with iron oxide: Characterization and catalytic activity for phenol oxidation by Fenton-like reaction

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Release and releasing kinetics of Cu in polluted soils treated with crushed mussel shell

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Interactions of organic compounds with soil components – elucidating mechanisms on a molecular level

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Short-Medium term effect of management and amendment on organic matter content and aggregate stability under wet Mediterranean climate

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Influence of the soil type and soil management in the soil quality and soil ultramicrofabric in olive crops from Sierra Mágina, Jaén

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The role of microorganisms in the association of soil organic matter with minerals: a ¹³C labeling and HPLC-IRMS approach

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Fractional distribution and dissipation of pentachlorophenol in the rhizosphere of rice (*Oryza sativa* L.)

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Microbial biomass activity in neotropical savanna soils managed during six years with conservationist cereal-cattle systems

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The background of non-crystalline materials and its role in soil organic matter turnover in subtropical volcanic soils

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Organo-mineral features related to field infiltration parameters in calcimorphic Mediterranean agricultural soils

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Adsorption of the insecticidal protein of *Bacillus thuringiensis* subsp. *kurstaki* by soils: effects of iron and aluminium oxides

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Calcified roots argue for the heterotrophic lifestyle of branched tetraether source bacteria

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Sorption of acidic organic solute onto kaolinitic soils from methanol-water mixtures

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The nitrogen storage related to soil properties in clay and sandy soils of Tunisia

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Changes in land use of contaminated sandy soils modify their trace metal availability

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J,K,L

Humic acids from Podzols under mountain pine in various stage of degradation – FTIR and 13C NMR study

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Soil carbon evolution and enzymes activity in sludge treated agricultural soil

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Soil structure effect on the biodegradation of native and added organic matter

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Understanding Phosphorus (P) dynamics in soils amended with repeated application of different organic amendments using the Diffusive Gradients in Thin-films (DGT) technique.

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As-species in agricultural soils with long-term fertilization

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Enhancement of phosphorus availability in acidic soils by using humic acid and crude fulvic acids

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Adsorption and catalytic activity of ectomycorrhizal fungal phosphatases in contact with two tropical soils

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Trends in soil properties with view to glomalin and structural stability relationship in abandoned terraced soils of NE Iberian Peninsula

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Microbial uptake of low-molecular-weight organic substances out-competes sorption in soil

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Effects of soil temperature and moisture regimes on concentrations and their corresponding natural $\delta^{13}\text{C}$ abundance along forest soil profile under two tree contrasting species

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Short-term changes in soil organic carbon contents in a low permeability and in barren land of South Korea under *Miscanthus* cultivation as a bioenergy crop

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Does the sensitivity of the soil organic matter mineralization to a change of temperature depends on its quality?

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HPLC Analysis of Chromophoric Dissolved Organic Matter in Antarctic Soil Core: Comparison with Microbiology Data

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Effect of cropping systems, mineral nitrogen (N) and crop residue on total soil microbial community under soybean in Meru south (Chuka) central highlands in Kenya

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Phosphate fertilizers and cereal/legume rotation improve crop yield and total microbial community diversity in soil of Western Kenya

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The influence of genetic peculiarities of soils on organic carbon content in the Amur river waters, middle and lower Priamurye, Russia

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Identifying genes involved in potassium-bearing mineral weathering by thermophilic fungus *Aspergillus fumigatus*

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Dynamic changes in bacterial communities during compost and earthworm treatment of low grade potassium ore

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Sorption Characteristics of the Major Components of Crude Oil to Vadose Zone Soils in Xinjiang Oilfield

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Influence of Soil Characteristics on the Efficiency of Iron Nanoparticles for Lead Immobilization

Carmen Lobo, Ruben Mujica, David Santos, Araceli Pérez-Sanz, Mar Gil-Diaz, Juan Alonso

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Background content of hydrocarbons in taiga zone soils

Evgeniy Lodygin, Vasily Beznosikov

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Chemical extractions of the mineral-associated SOM: an integrated approach for a functional fractionation

Luis Lopez-Sangil, Pere Rovira

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Changes in the microbial activity and biomass of soils from Mediterranean Mountain areas along an altitudinal gradient: interaction with tree species composition

Candel Perez David, Andrés-Abellán Manuela, Wic-Baena Consuelo, Picazo Córdoba Marta, López-Serrano Francisco Ramón, Bastida López Felipe, Lucas-Borja, Manuel Esteban

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What is the chemical nature of stable carbon ? Using soils from a long term bare fallow to answer this question.

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M,N

Agronomic performance of chickpea as influenced by trees in a Mediterranean agroforestry systems

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Nitrogen fixation and rhizodeposition of a metallicollous symbiotic association Anthyllis vulneraria/Mesorhizobium metallidurans grown in highly contaminated mine tailings by Zn, Pb and Cd

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Assessment of Soil Degradation Risks Caused by Priokhotie Mining Industry and the Role of Humus Substances in Soil Recultivation

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Phytate mineralising rhizobacteria are associated to common-bean nodulated root
Maougal Rim Tinhinen, Brauman Alain, Djakoun Abdelhamid 3, Plassard Claude, Drevon Jean-Jacques

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Heavy metal availability and their relationships with soil microbial characteristics in agricultural carbonated soils

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Fate of emerging organic pollutants (Antibiotics) in soils. The role of metal complexation.

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Dynamics of clay-fixed ammonium in soil as a source or sink of mineralized nitrogen in paddy ecosystems

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Characterization of soil organic matter and cyanobacterial diversity of microbiotic crusts in a desert scrub of the Baj California peninsula, Mexico

Yolanda Maya, Norma E. García-Calderón, José P. Gómez-Sánchez, Sara Solís-Valdéz 3

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Effects of climate change parameters on the availability of cations in the soil water

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Calcium Sulfate effect on Nutrient Content and Antioxidant Activity in Highbush Blueberry Subjected to Phytotoxic Aluminum

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An automated continuous flow $^{13}\text{CO}_2$ and ^{15}N labelling system to estimates the ^{13}C and ^{15}N flow of enriched root exudates in the soil solution of crop rizospheres

Carlos Monreal, Matus Francisco, Marc Lefebvre, Shan-Shan Wu, Raymond Desjardins, Maria DeRosa

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Seasonal effects on soil nutrient dynamics in halophyte grassland at Cuatrociénegas valley, Mexico

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Management-specific distribution and stabilization of organic carbon within macroaggregates from arable soils

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Use of organic matter mixed with calcium carbonate pendants in order to record climate change in semiarid soils of Rashakan region, Urmia, Iran

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Effect of different vermicompost tea on zink, iron and phosphorus concentration and uptake in wheat

Samaneh Rahmatpour, Hossein Ali Alikhani, Rokhsareh Khalili, Leila Mohammadi

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Evaluating Auxin hormone production ability of some indigenous pseudomonas fluorescent strains isolated from Iranian soybean cultivated farm lands

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Changes in soil quality indicators under humic substances application in liquid form

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Changes in zinc adsorption in an alkaline soil in the presence natural humic substances

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Evolution of microbial populations and its relation with humic and fulvic acids availability in a composting process

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Description of the adsorption of Cu and Zn on allophanic clay using the Capacitance Constant Model

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Isolation and screening of potential plant growth promoting rhizobacteria from pastures established on a Chilean volcanic soil

Oscar A Martinez, Milko Jorquera, María de la Luz Mora

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The role of metal accumulation in the laurel forest of La Gomera (Canary Islands, Spain)

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Effects of flooding and drying on the solubility of soil nutrients evaluated at watershed and regional scales

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Changes of humus, caused by interactions with heavy metals

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Study on the effects of long terms green manure application with C/N different levels on soil aggregate stability and equations of water infiltration in Maragheh dryland condition

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Use of soil micromorphological studies to explain some soil characteristic changes by rye green manure application

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Assessing the disturbance of soils amended with high amounts of urban residues through testing the metabolic activities of microbial communities

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Effect of organic amendment and vegetation of vineyard soils on copper distribution at the micro-aggregate scale

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Carbon mineralization potential and priming in volcanic soil of pristine temperate old-growth rain forests in Southern Chile

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Carbon sequestration in organic matter fractions of different ecosystems

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The binding of selected monosaccharides to ferrihydrite by adsorption and coprecipitation- investigated by desorption experiments, infrared spectroscopy (FTIR) and N₂ gas adsorption measurements

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Interaction of selected minerals with organic pollutants: Effects of Phyto-assisted Bioremediation using *Vigna subterranea*

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Exploration of Environmental Changes as a Result of Anthropogenic Influences at Watery Habitats

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Investigation of Slope Sediment of Red Clay Rendzina

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O,P,Q

Hedges of vetiver grass (*Vetiveria zizanioides*) for remediation of vertisol and lixisol.

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Salinity decreases dissolved organic carbon in the rhizosphere and increases trace elements phytoaccumulation

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Soil N mineralization and microbial biomass carbon as affected by deforestation induced rise in soil temperature in the hot humid tropics

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Multi-parameter approach to assess short-and long-term effect of olive mill waste water land spreading on soil quality

Claudia Di Bene, Elisa Pellegrino, Marta Debolini, Nicola Silvestri, Mariassunta Galli, Enrico Bonari

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Potential of C retention in silt and clay fractions of a Brazilian subtropical Oxisol as affected by soil management systems

Deborah Pinheiro Dick, Cecilia Estima Sacramento dos Reis, Graciele Sarante Santana, Jennifer da Silva Caldas, Vanessa Aparecida dos Santos Silva, Cimelio Bayer

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Ectomycorrhizal fungi and mobilisation of organic phosphorus from forest soil: myth or reality?

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Adsorption and oxidative transformation of phenolic acids by Fe(III)-montmorillonite

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Adsorption of humic acid on hematite: effects of pH and ionic strength

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Dynamic of soil structuration by earthworms - Influence of earthworms on soil organic matter composition and bacterial communities

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R, S, T

Investigating the relation between soil mineralogy and microbial communities in a landscape study

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Organic amendments as tool for a sustainable management of intensive agriculture

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Bonanomi 3, Rosaria D'Ascoli, Astolfo Zoina 3, Maria A. Rao

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Adsorption of prion protein on organo-mineral complexes and Scottish soils

Jun Zhu, Maria A. Rao, Massimo Pigna, Vincenza Cozzolino, Antonio Violante

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Fast Field Cycling NMR relaxometry: a new tool to assess the effects of organic amendments on a agricultural soil from Southern Italy

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Variation on photosynthetic performance and its relationship with antioxidative systems in perennial ryegrass cultivars exposed to manganese excess

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Contrasting soil structures in long term bare fallow treatments and its relation to C storage in soil: is organic matter physically protected in the long term?

Remigio Paradelo, Claire Chenu, Folkert Van Oort

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Land use-related modification of labile carbon fractions in soils from Galicia (NW Spain)

Remigio Paradelo, Claire Chenu, María Teresa Barral

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Amelioration of aluminium toxicity by calcium sulfate in Highbush Blueberry (Vaccinium corymbosum L.)

Marjorie Reyes-Díaz, Cristian Meriño-Gergichevich, Miren Alberdi

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Application of stabilized Fe⁰ nanoparticles for remediation of Cr (VI)-spiked soil

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Gypsum application ameliorates Al-stress in Vaccinium corymbosum L. growing in an Andisol: A cultivar dependent effect.

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Carbon stocks and carbon management index in physical fractions of a highland Oxisol as affected by pasture management systems

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Chemical composition of soil organic matter stored in cryoturbated arctic soil

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Microbial utilization of the C sources in functional SOC pools with regard to their stability and structural microbial community composition

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No tillage affects soil organic matter, glomalin and soil properties in an alfisol of central-south Chile

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Organic acids exuded from two aluminium tolerant wheat cultivars in short and long term by hydroponic systems with increasing aluminium levels

Alex Seguel, Gustavo Curaqueo, Ernest Smith, Jonathan Cumming, Fernando Borie

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Applying ArcGIS Geostatistical Analyst for zoning of some soil biological properties affected by different land uses

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Storage of organic matter in silt-sized and clay-sized fractions of soils as influenced by compost application

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Changes in soil chemical properties with different tillage systems and crop rotations in a semi-arid area of Castille-Leon, Spain

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Copper in a Vineyard Soil Variably Amended with Organic Matter: Organic Matter, Cu Distribution and Speciation Relationships

Aline Navel, Lorenzo Spadini, Jean Martins, Alain Manceau, Isabelle Lamy 3, Pierre Faure 4, Lionel Ranjard 5, Pierre-Alain Maron 5, Simon Tymen, Erwann Vince, Virginie Nowak 5

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Drug-resistant microorganisms in soils fertilized with sewage sludge.

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Sonochemical effects in solutions of humic substances

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Degradation of the pesticide MCPA in the detritosphere – A new mathematical model

Holger Pagel, Christian Poll, Joachim Ingwersen, Ellen Kandeler, Thilo Streck

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Effect of organic amendment on the microbial growth, activity and functional diversity of a soil under intensive agricultural management

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Bacterial community structure and enzymatic activity in an agricultural volcanic soil of southern Chile as affected by addition of sludge from pulp and paper industry

Salma Sultana, Rosaria D'Ascoli, Milko A. Jorquera, Maria Jose Flores, Rolando Demanet Philippi, Maria A. Rao 3, Felipe Gallardo, Maria de la Luz Mora

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Metals in soils amended with biosolids

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Influence of lysozyme complexation with humic acid on the lysozyme activity

WenFeng Tan, Yan Li, Luuk Koopal, Willem Norde

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Effect of soil type on extracellular enzyme activity and nutrient dynamics in two halophilous grasslands in northern Mexico

Yunuen Tapia-Torres, Gerardo Vázquez Marrufo, Felipe García-Oliva

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Modifications to soil C stock in a maize soil afforested with Populus alba L.

Elena García-Campos, Félix Zorita, Fernando Gil-Sotres, M. Carmen Leirós, Carmen Trasar-Cepeda

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Sorption of the new herbicide aminocyclopyrachlor by cation modified clays

Alegria Cabrera, Carmen Trigo, Lucia Cox, Carmen Hermosin, Juan Cornejo, Willian, Koskinen

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Chitosan-intercalated montmorillonite as an adsorbent of the herbicide clopyralid in aqueous solution and soil/water suspensions

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Manganese effect on lignin degradation degree in beech (*Fagus sylvatica* L.) leaf litters

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U, V, W, X, Y, Z

Interrelation between CO₂ and CH₄ production with biological activity and soil properties

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SOC pools dynamics and stability in the 80 years bare fallow chronosequence at Versailles. Evidence of mineral-associated SOC stabilization

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Study of acid phosphatase immobilization mechanism in nanoclay using confocal microscopy

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Hydroxy- and fluorapatite as sorbents in Cd(II) - Zn(II) multicomponent solution in the presence of EDTA

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Key soil factors influencing the transfer of 17 elements from soils to young leaves of Tieguanyin tea in the south of Fujian Province, PR China

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Clay mineralogy of soils derived from different granitoides in a temperate climate of Sudety Mountains, Poland

Jerzy Weber, Jaroslaw Szadorski, Rafal Tyszka, Magdalena Debicka, Andrzej Kocowicz

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Exogenous isolation of Inc-P1 plasmids from copper-affected soils

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Molecular characterization of novel Stenotrophomonas sp. strains isolated from a copper-affected agricultural soil

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Thermodynamic database updating to include synthetic chelating agents for soil behavior prediction

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Effect of afforestation on soil CO2 emissions

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Abstracts

Keynote presentations

The Role of Soil Fungi in Biological Weathering and Soil Formation

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Estimates of soil erosion for conventionally farmed land are up to 100 times faster than natural rates of soil formation (Montgomery, 2007). As a consequence, soil is considered to be a finite resource. Sustaining the soil resource for food production and many other ecosystem services, requires that mechanisms and rates of soil formation are elucidated and quantified. This is both to assess risks to soil fertility, but also to understand if soil formation processes are amenable to manipulation and acceleration as part of land management. Key among the processes driving pedogenesis is the delivery of plant photosynthate into the subsurface weathering environment as chemical energy that drives mineral dissolution. Plants and their mycorrhizal symbionts deliver 10-30% of the above-ground carbon supply to the soil environment (Taylor et al., 2009, and included references), where mycorrhiza drive chemical dissolution of minerals in order to release and supply back to their plant hosts, bioavailable mineral nutrients such as phosphorous and potassium.

Our hypothesis is that rates of mineral weathering are driven by, and proportional to, the rate of carbon supply delivered by the mycorrhizal fungal network to the weathering arena at the scale of reacting mineral grains. The research methodology is to quantify carbon allocation through ¹⁴CO₂ pulse-labelling of host plants, and autoradiography tracking of carbon-14 within the microcosm system; plant, roots, fungal mycelia, and mineral grains. Specific tracking of mineral calcium and strontium provides a metric for element mass transfer. Scanning Electron Microscopy with elemental mapping, wet chemical analysis of low weight organic acids extracted from the weathering arenas of the microcosms, and FTIR microspectroscopy, confirm that calcium and strontium translocation occurs from the minerals. Quantitative analysis by Ion Coupled Plasma Emission Spectroscopy of Ca and Sr released from the minerals, confirms that the degree of mass transfer from the mineral broadly correlates with carbon photosynthate supply to the weathering arena. These microcosms are maintained at unsaturated hydraulic conditions without active flushing by water flow. As a consequence, secondary minerals, identified as calcium oxalate reach saturation and precipitate within the weathering arenas.

These results demonstrate a strong correlative relationship between carbon supply and Ca and Sr mass transfer from the mineral grains. Speculation on a causative relationship includes chemical weathering driven by the supply of low weight organic acids, of which oxalic acid dominates in these experiments.

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Understanding changes in soil carbon stocks and global change

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Most terrestrial carbon exists as one form or another of soil organic matter, and the terrestrial carbon cycle is mediated by various microbial SOM transformations and the effects of plants and soil biota on them. The sensitivities of these processes to soil temperature and moisture are poorly understood, leading to major uncertainties – via feedback – in predictions of future climate change. This severely constrains efforts to model the terrestrial carbon cycle and its feedback with climate change. This talk will deal with definitions of soil carbon, geographic aspects of soil carbon deposition, current understanding of natural changes in soil carbon stocks, and methods for measurement and modelling of soil carbon. I will discuss the difficulties in predicting the effects of climate change on soil carbon and possible climate-carbon cycle feedbacks. I will use the results of the National Soil Inventory of England and Wales for illustration.

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The influence of surface polymer coatings on adhesion of bacteria and biofilm formation

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Bacteria, and other micro-organisms, are essential for the biological activity in natural environments, such as soils and sediments. More than 95% of the bacterial mass exists in biofilms at surfaces. It suggests that association with surfaces is beneficial. Indeed, bacteria may adhere to survive: (1) nutrients tend to accumulate (adsorb) at surfaces and this is a good reason for bacteria to adhere there as well; (2) bacteria stick at surfaces to avoid transport by flow to a hostile environment, and (3) in a biofilm bacteria are less susceptible to external attacks, such as by antibiotics.

Using a model system we addressed the influence of the presence of highly hydrated, extended polymers at the surface on subsequent bacterial adhesion and biofilm formation. Polymer (polyethylene oxide)-coated and pristine (silicon) surfaces were exposed to suspensions of three bacterial strains, i.e., *Staphylococcus aureus*, *Staphylococcus epidermidis* and *Pseudomonas aeruginosa*. Deposition on the polymer coating was strongly suppressed for the staphylococcal strains. In spite of reduced adhesion, biofilms did develop on the polymer-coated surface, albeit at a reduced rate and in contrast to the ones at the pristine surface, the staphylococcal biofilms almost completely detached from the polymer-coated surface under fluid shear. Adhesion, growth and detachment of *P. aeruginosa* were not significantly influenced by the polymer coating. Furthermore, and most importantly, the morphology of the biofilm of all strains is strongly influenced by the polymer coating, resulting in a higher viability and a higher sensitivity to antibiotics.

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Plant-soil-microbe interactions: importance for plant performance, nutrient cycling and adaptation to environmental changes

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Plants interact and are associated with a high diversity of microorganisms, particularly in the rhizosphere and the plant interior. Plant-associated bacteria have important functions as they essentially influence plant growth and health. They can provide nutrients through N₂ fixation or through other mechanisms and support plant growth by the production of phytohormones, siderophores of 1-aminocyclopropane-1-carboxylate deaminase. Phytopathogens are controlled by antibiotic-producing microorganisms or by microbes inducing systemic resistance in plants. Plant-microbe interactions play also a major role in nutrient cycling. Due to various mechanisms plant-associated microorganisms are important for the adaptation of plants to stressful situations, which might be adaptation to environmental change, stress due to high temperature, drought or soil contamination.

The role of endophytes, i.e. bacteria living in the plant interior without showing pathogenicity to their host, for plant growth promotion, nutrient cycling and adaptation to stress will be shown. We furthermore will discuss, which types of bacteria interact with plants including bacteria with potential pathogenicity to humans, and discuss the relevance of plant-soil-microbe interactions for agriculture and food safety.

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Is there a limit to the extent of the rare biosphere in soil?

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The complete exploration of soil bacterial diversity is hindered by conceptual limitations including complexity and heterogeneity of the soil matrix and disparity in the size of bacterial populations. Actually, the larger part of the cells in soil belongs to a few numbers of species while the majority of the bacterial diversity is composed of populations with a very low number of representatives. Although these minority populations are likely to play an important role in the functioning of the community, they are rarely detected by conventional techniques characterized by DNA extraction bias and insufficient characterization.

A new conceptual approach was developed to access bacterial diversity by fostering the development of minority bacteria through inoculation of bacterial communities into new sterilized soil samples with physicochemical properties differing from those of their native soils. By using 16S rDNA microarrays (phylochips) to analyze bacterial populations newly developed in the soil microcosms numerous previously undetected bacteria were identified, confirming the presence of minority populations in soil and the possibility of increasing their relative abundance. This approach was used to reveal the rare biosphere in Park Grass-Rothamsted soil (UK) investigated in the frame of the Terragenome program with a forest soil from Italy as recipient, opening new perspectives to sequence the complete metagenome of the reference soil.

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New Analytical Approaches for Investigating Reaction Mechanisms at Carbon/Mineral and Metal(loid)/Mineral Interfaces

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Over the past few years a number of advanced analytical techniques, especially those involving synchrotron-based radiation, have provided environmental scientists important tools to investigate biogeochemical processes at mineral/microbe interfaces that involve nutrients such as C, N, and P as well as toxic metal(loids) such as As and Cr. Additionally, one can now measure in-real time, and at the molecular and atomic scales, the kinetics of meta(loid) transformations at mineral interfaces. Two applications of these techniques will be discussed in this presentation. Carbon near edge X-ray absorption fine structure (NEXAFS) spectroscopy and scanning transmission X-ray microscopy (STXM), complemented with Pyrolysis field ionization mass spectrometry (Py-FIMS), were employed to study the association of soil organic matter with minerals, particularly Fe-oxides along a landscape redox gradient. The association of organic matter (OM) with minerals has been increasingly recognized as a major process for protecting organic matter against microbial degradation in soils. Iron oxides are of particular importance given their abundance in soils and high reactive surface area. Iron is susceptible to redox variability along landscape gradients. Reductive dissolution of iron minerals governs the amount, form and transport of sequestered C, and thus terrestrial carbon cycling. Quick X-ray absorption spectroscopy (Q-XAS) was used to measure the rapid kinetics of As(III) and Cr(III) oxidation on manganese oxides. Manganese oxides are the most important oxidants of contaminants such as As and Cr in the soil environment. Yet the mechanisms for these reactions are poorly understood. The Q-XAS studies were augmented with macroscopic stirred-flow kinetic studies to provide a multi-scale assessment of the reaction mechanisms.

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Environmental Fate and Toxicity of Engineered Nanoparticles

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Engineered nanoparticles (in a range of 1-100 nm) are found in increasing number of products (such as socks and paints) and applications (e.g., biomedical, electronic and environmental) due to the rapid development of nanotechnology. Therefore, engineered nanoparticles (ENPs) will be inevitably introduced into the environment from intentional application, accidental release, and disposal at the end of life-cycle of the ENPs-containing products. As a matter of fact, ENPs have already been reported entering the environment as a result of using ENPs-containing paints. Currently, the development of ENPs and their applications have outpaced the research on their potential health and environmental risks. Recent toxicological data do raise concerns over the environmental and health impact of ENPs. The environmental and health risk of ENPs will be largely determined by their fate, mobility, and bioavailability. Dissolved organic matter (DOM) is ubiquitous, and will interact with ENPs upon contact, thus potentially affecting their interfacial processes (such as sorption), aggregation, transport, bioavailability, and toxicity in the environment. Therefore, in this paper, colloidal behavior of selected carbon nanotubes (CNT) and oxide nanoparticles in the presence of DOM will be addressed and mechanistic discussion will be presented. Moreover, how DOM affects the transport of ENPs in porous media will be illustrated. In addition, the effect of DOM on sorption of organic contaminants at the interface between water and ENPs will be examined. Further, how pH, ionic strength, and types of cations change the suspension stability of ENPs will be evaluated in terms of zeta potential, hydrodynamic particle size, steric repulsion, and critical coagulation concentration. Also, the toxicity of CuO nanoparticles (as an example) to algae in both absence and presence DOM will be shown. In the end, it is hoped that this presentation will demonstrate the critical role of DOM in determining the fate, mobility, and bioavailability of ENPs, therefore urging a better understanding of the interactions between ENPs and DOM for more accurately estimating and modeling the ecological exposure and risk of ENMs.

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Abstracts

**Oral Presentations
by session**

Session 1

Dynamics and stocks of C and N in soil

Carbon stock in soils: effect of vegetation, soil type and climatic conditions on the western Himalaya, India

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Soils are the third biggest sink of carbon on the earth. Hence, a suitable land use for a climatic condition is expected to sequester maximum atmospheric carbon in soils. But, information on how land uses and soil types influence carbon accumulation in soils under different climatic conditions is meager. This study reports the impact of climatic conditions, land uses and soil types on the concentration and stock of soil organic carbon (SOC) in 0-30 cm and 30-100 cm soil depths on the western Himalaya, India. Using multi-seasonal IRS 1C- LISS III data for land uses and soil maps of the study area, total thirty five soil-land use units were selected for the study. Soils were sampled from 35 soil-land use units from 5567 km² area. SOC concentration was estimated by the Walkley and Black rapid titration method; SOC stock was computed by multiplying SOC concentration with bulk density and thickness of respective soil depth. The SOC stocks of the 35 soil-land use units were subjected to Principle Component Analysis (PCA). The PCA identified four climatic conditions (upper alpine, lower alpine, temperate and sub-tropical), six land uses (Abies-Rhododendron forest, Pine forest, Broad leaf (Quercus) forest, Agriculture and Horticulture) and nine soil types (Udorthents, Udifluents, Eutrudepts, Dystrudepts, Hapludolls, Hapludepts, Cryofluents, Eutrocryepts, Cryorthents). Pearson correlation coefficients were calculated to compare explanatory variables (rainfall, soil temperature, altitude, land use factor, slope) and response variables (PCA axes scores, fine particles, pH, bulk density, SOC concentration and stock in 0-30 cm and 30-100 cm soil depths) to know the drivers that influence the SOC stock build up. Results revealed that the SOC concentration and stock in 0-30 cm were the highest in the temperate and the lowest in the sub-tropical conditions. In all climatic conditions other than temperate the SOC concentration and stock were greater in the forests and horticulture compared to the agriculture. The SOC attributes in both depths were inversely correlated to soil temperature and slope, but positively correlated to soil moisture, altitude, land use factor and fine soil particles; these factors together explained 98% variability in SOC stock. Relation of SOC stock, across land uses and climatic conditions, was quadratic with temperature suggesting that for each centigrade increase in temperature there would loss of 1.046 Mg C ha⁻¹ from the Himalaya.

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Global-scale topsoil carbon turnover depends upon vegetation type

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Radiocarbon content of soil allows estimation of Soil Organic Carbon (SOC) turnover on timescales of decades and longer. Using radiocarbon data on topsoil-carbon collated from the literature, SOC turnover was modelled by means of a simple steady-state multiple-pool approach. Plant Functional Types (PFTs) were used to interpret the broad differences in SOC age and turnover characteristics, specifically forested systems and non-forested systems. Obtaining a Mean Residence Time value from a simple single-pool model showed forested systems to turnover C significantly faster than non-forests. Expanding to multiple pool models revealed that input to, and size of, SOC pools with a 20 year (slow) or 1000 year (passive) turnover suggested a fundamental difference between the two PFTs, with non-forested systems having a significantly larger amount (and portion) of SOC turned over in the passive pool. Despite there being PFT-dependent latitudinal effect on the MRT, broad climatic features had no explanatory power over the observed results.

The results suggest a functional difference in the topsoil SOC turnover dynamics between major vegetation types, with possible implications in terms of SOC pool resilience given land-use change and a changing climate, as well as the potential to feed in to DGVMs and other model approaches.

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The biological link to the chemistry of humification

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For more than 200 years, most investigations on the chemistry of humic substances (HS) and soil organic matter (SOM) have been conducted to a large extent by soil chemists with limited contribution from soil microbiologists. As a result, progress achieved in our knowledge of the molecular structure of SOM and HS has been slow. Within this context, close cooperation between microbiologists, biochemists, and chemists is necessary.

This presentation discusses current knowledge in the context of criticisms of HS and their structure, and proposes new chemical and biological reactions that synthesize a central unit structure (CUS) of humic acids (HA) and SOM. We indicate how the application of recent advances in the microbiology of natural substances may assist soil chemists and ecologists in their work elucidating the chemical structure of HS and SOM. The continuous microbial production of complex polyketides (PKs) from simple soil soluble molecules contributes to the second stage of humification or HS synthesis. The PKs involve stable and complex alkylaromatic, aromatic, polyaromatic, phenolic and polyphenolic structures. Due to their bioactivity, rapid physico-chemical adsorption and high energy content in their chemical bonds, formed PKs represent kinetically passive soil carbon pools, and so lend themselves as carbon skeletons contributing to the formation of a stable CUS in soil humic substance Carlos.Monreal@AGR.GC.CAs (HS) and SOM.

Presenting author: Carlos Monreal

Unraveling the fate of dissolved organic N in soils using ¹⁵N tracing

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Determination of the isotopic signature of dissolved organic nitrogen (DON) is important to assess its dynamics in terrestrial ecosystems. Analysis of ¹⁵N-DON, however, has been hindered by the lack of simple, reliable, and established methods.

We evaluate three off-line techniques for measuring the ¹⁵N signature of DON in the presence of inorganic N using a persulfate digestion followed by micro-diffusion. The ¹⁵N-DON signature is calculated from the difference between total dissolved ¹⁵N (¹⁵N-TDN) and inorganic ¹⁵N. We quantified the ¹⁵N recovery and signature of DON, NH₄, and NO₃ in a series of inorganic N/DON mixtures (with a TDN concentration of 10 mg N L⁻¹) for three lab protocols. Phenylalanine was used as a model compound for DON.

The best lab protocol determined the concentration of inorganic N and TDN prior to diffusion using improved spectrophotometric techniques. An accuracy of 88% for ¹⁵N-DON should be routinely possible; coefficient of variation was <2.9%. Hence, reliable ¹⁵N-DON values are obtained over an DON concentration range of 2.3-10 mg L⁻¹. High levels of DON could influence the accuracy of ¹⁵N-NO₃ mainly at DON:NO₃ ratios above 0.4. Our method is applicable for soil solution samples and soil extracts and has no risk of cross-contamination. Potential applications are large, in particular for ¹⁵N tracer studies, and will increase our insight in DON behaviour in soils.

We applied this micro-diffusion method to understand the fate of several dissolved and extractable organic N fractions in soil (organic N extractable with CaCl₂ on dried and moist soil, with hot water, and with K₂SO₄), in combination with isotopic analysis of biomass N, particulate organic N, and mineral associated N. Results (preliminary) and application possibilities of the micro-diffusion method will be discussed.

References (use of ¹⁵N tracing)

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Biochar suppression of N₂O emissions from an agricultural soil

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Biochar is biomass that has been partially combusted in a low oxygen environment that is used as a soil amendment. As a carbon rich material with a slow degradation rate, it can be used to sequester carbon in the soil, thus mitigating global climate change. Agriculture contributes ~ 13.5 % to anthropogenic greenhouse gas emissions (IPCC, 2007), with N₂O emissions representing a large fraction of this. Studies have shown that N₂O emissions may be significantly suppressed in agricultural systems following the addition of biochar to soil.

The aims of this study were to determine the effects of biochar addition, temperature and moisture on greenhouse gas emissions (CO₂, CH₄ and N₂O) from soil. We incubated clayey soils collected from a UK bioenergy plantation (*Miscanthus Gig X*) with and without biochar at three temperatures (4 °C, 11 °C and 17 °C). Biochar was incorporated into the top 8 cm of the soil cores with parallel control cores disturbed to 8 cm. Biochar, derived from hardwood feedstock (<2mm), was incorporated at 2 % by dry soil weight (typical core wt. 2 kg). Half the soil cores were subjected to wetting events to stimulate N₂O emissions, and greenhouse gas emissions were monitored for 72 hours using a static chamber approach. It was found that at 11 °C and 17 °C, N₂O emissions from the biochar treatments were significantly lower ($p < 0.05$) than N₂O emissions from the non-biochar treatments, at least 60 % lower within 24 hours of wetting.

We hypothesised that the observed suppression of N₂O may be in response to changes in water holding capacity of the biochar-amended soils. In order to investigate this, ground, field-moist soil (approx. 25 g d. wt.) was mixed with hardwood biochar (< 2 mm) at rates from 0 to 10 % biochar (w:w). These mixtures were placed into Wheaton bottles and their moisture content adjusted to 87 % of water holding capacity, in order to remove the influence of the higher relative water holding capacity of biochar compared to the soil across treatments. Headspace greenhouse gas concentrations were monitored for seven days. It was found that N₂O emissions were significantly suppressed with 5 and 10 % biochar addition, approximately 65 % and 97 % suppression respectively.

We conclude that the increased water holding capacity of hardwood biochar and soil mixes relative to soil alone cannot explain the observed suppression of N₂O emissions. Future research will investigate the potential mechanisms behind this effect.

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Non symbiotic N₂ fixation; a misunderstood and underestimated N input?

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The reduction of atmospheric di-nitrogen (N₂) to bioavailable ammonium (NH₄) is the main route of entry for new nitrogen (N) into ecosystems. It influences plant growth and carbon exchange at local to global scales. N₂ fixation also plays a critical role in ecosystem functions and ecosystem response to global climate change. However, our understanding of processes controlling N₂ fixation at the ecosystem scale remains elusive as illustrated by the systematic underestimation of N₂ fixation by models for N budget at regional and global scales, especially in terrestrial ecosystems. This might be the result of a misconception of N₂ fixation itself, in which the contribution from free-living N₂ fixers is largely under evaluated, compared to that of symbiotic fixers (e.g. legumes). Contrary to symbiotic systems, in which N₂ fixation is catalyzed by only one enzyme (Mo-Nase), three nitrogenases are associated with non-symbiotic N₂ fixing biomes. Almost three decades after the discovery of these so-called alternative nitrogenases (V-Nase and Fe-Nase) their exact role on natural N input remains unknown.

Here I will present recent results on micronutrient (Mo, V and Fe) speciation in soil, the limitation of non-symbiotic N₂ fixation by Mo in terrestrial ecosystems and micronutrient uptake and homeostasis by free-living N₂ fixers. From these results emerges a new picture of the role of micronutrient dynamics on N₂ fixation at the ecosystem scale. It appears that higher plants can significantly impact micronutrient cycling to create a soil environment favorable to non-symbiotic N₂ fixation and that non-symbiotic N₂ fixation in leaf litter could thus be considered as a short-cut to the classical symbiotic N₂ fixation. It also arises that the role of alternative Nases on global non-symbiotic N input may have been largely underestimated. Finally, I will discuss the means by which estimates for non-symbiotic N₂ fixation, and hence global N input, could be improved; better estimates for N₂ fixation requires both a deep revision of our conceptual view of non-symbiotic N₂ fixation and the development of new and innovative analytical technics for the study of non-symbiotic N₂ fixing biomes.

Solving the N₂ fixation conundrum is a *sine qua non* condition to predict ecosystem response to global climate change in a comprehensive manner. A better understanding of non-symbiotic N₂ fixation bears hope for significant breakthroughs that must be explored.

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An Integrated Analysis of Soil Incubation Data: Deriving Soil Type Dependent Moisture-Respiration Relations

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One of the most important factors affecting soil carbon mineralization is soil moisture. Water content limits respiration either by the availability of water itself (affecting mobility and osmotic potential) or by limiting oxygen diffusion. The general relation between soil moisture and the production of CO₂, integrated into all widely used soil carbon dynamics models, has been described to various levels of detail for individual soils. Although this relation can vary largely between soils, a lack of information concerning its variation across soil types leads to most models applying only one moisture function to all cases. The associated uncertainties in soil carbon dynamics models could lead, as a consequence, to widely wrong predictions of soil carbon stock changes.

Soil incubations in the laboratory are well suited for obtaining precise relationships between variables, avoiding the problem of confounded or uncontrolled variables common in the field. Using multiple datasets from laboratory studies, we performed an analysis with the aim of uncovering relations between moisture effects on soil respiration and a range of soil characteristics, both as a means of improving the modeling of moisture effects across soils and identifying underrepresented soil types where further studies can advance our understanding. We compiled data on soil incubations from multiple sources where soil moisture was varied and monitored along with respiration. After processing the data for unit homogenization and quality control, we explored and chose the best fitting functions for each dataset separately. We next calculated the rate of relative increase in respiration for each dataset range and percent value of moisture. Using this common unit, we were able to calculate means and confidence intervals along the moisture axis, and most importantly, to relate them by regression to soil physical characteristics. We show significant emergent relations between soil characteristics (bulk density, pore space, organic carbon and texture) and the moisture effect on respiration, strongly dependent on the moisture content and the type of moisture measure.

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Temperature effect on soil organic matter mineralization in arctic soils from Norway, Svalbard and Russia.

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Soil organic matter (SOM) in arctic and boreal soils is the largest terrestrial reservoir of carbon. Increased SOM mineralization under increased temperature has the potential to spur a massive release of CO₂. Precise parametrisation of the response of arctic soils to increased temperatures is therefore crucial for correctly simulating our future climate. Here, we investigated the temperature sensitivity response of SOM mineralization in eight arctic soils of Norway, Svalbard and Russia. Samples were collected at two depths in mineral and organic soils, which were affected or not by permafrost. Samples were incubated for 91 days at 4, 8, 12, and 16 °C. We modelled the temperature sensitivity response with a first-order kinetics model with one labile and one recalcitrant SOM pools. The labile pool significantly improved model fit only for mineral soils, although it represented less than 0.5 % of the total SOM. In this case, temperature sensitivities of the labile and recalcitrant SOM pools were not significantly different. Temperature sensitivities of the labile pool in mineral soils and recalcitrant pools in both organic and mineral soils appeared affected neither by soil depth nor by the presence of permafrost. The temperature sensitivity of the dominant recalcitrant pool was higher in organic than in mineral soils. In conclusion, our study suggests that organic vs. mineral soil type, more than soil depth is the main controller of temperature sensitivity of SOM mineralization in arctic soils.

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Turnover of charcoal in fire-prone mineral soils of Southern Europe

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As a consequence of a global climate warming, extended dry and hot periods are predicted, which favor vegetation fires and the production of charcoal. Incorporated into the soil, this material is considered as highly recalcitrant and to increase the soil C sink. Recent laboratory experiments indicated that under optimal conditions, plant-derived pyrogenic organic matter (PyOM) can exhibit very short residence times < 100 years. On the other hand, charcoal artifacts in fossil sediments and Neolithic soils seem to contradict with those observations, confirming that although degradation occurs, some PyOM survives on a long term scale. To bring some light onto the fate and stability of PyOM, soil chronosequences with different recovery time after fire were analyzed for soil organic matter (SOM) composition and PyOM content. The respective alterations were related to SOM degradation rates determined in controlled laboratory respiration experiments.

For the first chronosequence (Histic Humaquept) (Marshland of Doñana National Park, Southern Spain), samples were collected directly, 15 years and 19 years after a severe fire and from comparable locations that remained unaffected. The fire combusted the whole O layer (0–20 cm) and increased char content in the A horizon. Directly after fire, no PyOM was identified in deeper soil regions. After 19 years, the O layer recovered to approximately 5 cm, but only minor PyOM contributions were identified after acid dichromate oxidation. The mineral soil, on the other hand, revealed PyOM contents of up to 18% of the total C at depths > 30 cm. This clearly evidences a downward translocation of PyOM within the soil profile. Fast translocation of PyOM was also observed for a Cambisol from Central Spain, where PyOM content in the A horizon decreased from 30% to 24% within 1 and 24 years after fire mostly due to degradation. Comparable short turnover rates were determined in controlled laboratory studies of charred topsoils from Sierra de Aznalcóllar, Southern Spain, taken 1 month after an intense fire. The high carboxyl C contents typically detected in the aged PyOM increases its water solubility, allowing the observed downwards movement of PyOM in the soils. Further, the higher polarity enhances its susceptibility to microbial attack on the one hand, but also to adsorption on the mineral phase. The latter is likely to be an important mechanisms contributing to the high recalcitrance of PyOM in some environments.

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Charcoal production at mound kiln sites affects pedogenesis and soil capacity to stabilize organic carbon

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The traditional production of charcoal by mound kiln was very intensive until the beginning of the 20th century. The production process and charcoal addition to soil has the potential to be used as a long-term sink for atmospheric CO₂ due to the intrinsic recalcitrance of aromatic components against oxidation, while influencing the pedogenic processes governing the soil capacity to stabilize OC. We aim to study the impact of a charcoal production site on (i) soil development, and (ii) its capacity to stabilize organic carbon (OC). The experimental site is located in the Grand-Leez oak forest in the loessic silt belt of Belgium. The well drained and acidic (pH 3.8-4.3) soil is classified as a Luvisol with an argic horizon occurring at 30 cm depth. We carried out the mineralogical and pedological analysis (i) in an ancient charcoal production plot, and (ii) in the local reference forest soil. Moreover, we analyzed the content of labile and stable OC in organo-mineral (A, Ah), eluvial (E) and argic (Bt) horizons. Stable OC (S-OC) was defined as the pool of OC resistant against 6% NaOCl. In the S-OC pool, mineral-protected OC (MP-OC) was extracted by dissolution of minerals by 10% HF, and the resistant OC was considered as recalcitrant (R-OC).

The soil-pH increases by 0.6-0.8 units and the base saturation is until eight fold higher after the addition of charcoal. In the eluvial E horizon just below the charcoal accumulation, we observe a slight decrease of amorphous and crystalline iron oxides which are here the main providers of reactive hydroxylated surfaces for OC associations. This decrease can be due to chemical processes (neof ormation and dissolution) or physical process (thermal dehydroxylation of the different forms of FeOOH). The concentrations of MP-OC (1-1.8%) and R-OC (1.5-2.3%) in the A horizon (0-38cm) of the charcoal production plot and in the Ah horizon (0-7cm) of the reference luvisol are very similar. Charcoal as residues of slow pyrolysis thus strongly increases the amount of C stabilized in soil through intrinsic recalcitrance and charcoal-organo-mineral interactions. The slight decrease of the labile carbon content in the E horizon below charcoal accumulation can be due to C mineralization by the thermal treatment. Finally, the pedological modifications do not significantly influence the stable C pool. Therefore, the addition of charcoal will lead to higher C sequestration in topsoil without affecting the subsoil capacity to stabilize OC

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Heat waves and soil Mediterranean microbial communities

Differential influence of drought, high-temperature and perturbation duration

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The warming of the global climate system is unequivocal and general circulation models predict higher air temperature and less frequent, but larger precipitation events. Shifts in the frequency and intensity of drought events and heat-waves are especially true within the current Mediterranean context. These extreme events may affect the microbial biomass, the microbial activity and thereby the biodiversity and the function of soil. In this work, we studied short-term and long-term impacts of severe drought and high temperature (drought, drought-heat and heat perturbations) on a Mediterranean soil microbial structure (taxonomic and functional). Different durations of perturbation (2, 7, 14, 21 and 28 days) were performed. Short-term effects were studied one day after the end of each perturbation. Long-term impacts of the 21 days perturbation period were assessed for 42 days after the end of perturbation. The physiological profile of the community was then performed with the MicroResp™ method and the bacterial taxonomic structure was evaluated using Ribosomal Intergenic Spacer Analysis (RISA). At the short-term, basal respiration and substrate induced respiration and the RISA patterns obtained revealed that the duration of perturbation had an effect on microbial structure and function. Both taxonomic and functional structures change after 21 days of perturbation. At the long-term, these patterns revealed no resilience of the bacterial taxonomic structure in the case of soils subjected only to heat perturbation, whereas this structure was resilient in the case of the drought-heat perturbation. In contrast, catabolic diversity of microbial community was no resilient in the two cases. In this Mediterranean context, drought perturbation, which is the most common environmental stress that soil microorganisms experience, seemed to have the same effect on microbial structure as control. Moreover, the effects of heat perturbations seemed to be more important than the effects of drought perturbation on soil catabolic function and bacterial structure.

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Session 2

**Advances in physical and biological techniques to
study soil interfaces**

Overcoming practical constraints in the application of X-ray CT to soil science

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Soil structure and in particular the spatial organization of pores are key factors in regulating soil organic matter (SOM) dynamics and new techniques to study their interactions should be developed and/or refined. X-ray computed tomography (X-ray CT) is rapidly gaining importance as a technique to obtain three dimensional information about the soil structure in a non-destructive manner. However, the application of X-ray CT in soil biological studies has been limited by practical constraints. Firstly, a trade-off factor of 1000-2000 exists between X-ray CT resolution and object dimension and hence to achieve adequate resolution for biological studies sufficiently small soil cores are required (e.g. 10 μ m resolution for a 1cm diameter soil core = \pm 1g). However, most enzyme assessments and PLFA analyses require several grams of soil. Secondly, while X-ray CT emits only a low dose of ionizing radiation (\pm 5 Gy), the influence of this dose of ionizing radiation on decomposer organisms is unknown. To date, only the applicability of PLFA signature analysis following X-ray CT has been validated (Deacon et al., 2008), while no information exists on the impact on e.g. subsequent enzyme activity assessments and biological activity following X-ray CT treatments.

Therefore, batch studies with or without X-ray CT scanning, either prior to or during running soil incubation experiments will be set up. These experiments will examine the impact of X-ray CT scanning and/or object dimension on microbial community structure, nematode survival, C-mineralization and enzyme activities (e.g. β -glucosidase, hydrogenase). Additional factors such as scanning time and soil moisture loss during scanning will be looked at. The outcome of these investigations will provide crucial information on ideal experimental set-ups for using X-ray CT in studies of SOM dynamics.

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Soil interface composition at the submicron scale – applicability of NanoSIMS

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Soil processes controlling the stabilisation of soil organic matter or the sorption of nutrients and pollutants happen at submicron scales at different interfaces ranging from pure mineral and charcoal surfaces up to inner and outer spheres of soil aggregates. Clay minerals, iron and aluminium (hydr)oxides and charcoal are considered as major components controlling the formation of soil interfaces and aggregates which are relevant for sorption processes. Although the knowledge about the factors controlling these soil processes has substantially improved over the last years, these processes are still hard to evaluate in situ.

The analysis of biogeochemical processes and properties of soil interfaces at the submicron scale is strongly improved by the novel nano-scale secondary ion mass spectrometry (NanoSIMS). This technique allows the simultaneous analysis of up to seven ion species with high sensitivity and lateral resolution. With Cs⁺ as primary ions, negatively charged ions, like e.g. ¹²C⁻, ¹³C⁻, ¹²C¹⁴N⁻, ¹²C¹⁵N⁻, ²⁷Al¹⁶O⁻ and ²⁸Si⁻, are collected with a lateral resolution down to 50 nm. Using O⁻ as primary ion, positively charged ions like e.g. ²⁴Mg⁺, ⁴⁰Ca⁺ and ⁵⁶Fe⁺, are collected with a lateral resolution down to 150 nm. Thus, NanoSIMS allows for a comprehensive assessment of soil interfaces between organic and mineral spheres.

We will present results obtained at the NanoSIMS 50L at the TU München ranging from interfaces of black carbon clusters up to intact soil macroaggregates. With the help of isotopic tracers we were able to show the formation of OM hot spots on charcoal particles. By the application of labelled litter to natural soils, we were able to track the incorporation of fresh OM into soil aggregates and therefore the new formation of interfaces at particulate OM within aggregated soil spheres.

Additional to the presented elemental and isotopic imaging of interface composition, we will discuss shortly sample preparation requirements and restrictions for future NanoSIMS applications.

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Near infrared reflectance spectroscopy and molecular tools to evaluate land use impact on soil characteristics and microbiotaa case study in a tropical ecosystem (altitude plains, Lao PDR)

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The Plain of Jars is a vast, acid savannah grassland located in the western part of Xieng Khouang province, north-eastern Lao PDR where agricultural intensification has been promoted since the last decade to improve farmers livelihood. However, there is limited information to evaluate the impact of the promoted cropping systems on soil properties and biota. The early effect of five land use practices on top soil (0-10cm) chemical characteristics, structure and microbial communities was therefore investigated using both traditional and more recent tools and approaches. A conventional system based on soil ploughing was compared to three no-till systems based on different cover crops association and to the natural surrounding pastureland. Soil chemical characteristics were analyzed in laboratory (LAS, CIRAD, France). Soil aggregate stability was estimated by various aggregate indices combining aggregate size distribution after wet sieving (Yoder method) and soil texture. The bulk density was measured to evaluate soil macro porosity and values were added to aggregate stability indexes to estimate soil structure quality. Soil microbial diversity was evaluated by B-ARISA (bacterial automated ribosomal intergenic spacer analysis) fingerprints analysis. Near infrared reflectance spectroscopy (NIRS) was used both to evaluate which soil parameters could accurately be estimated and as interpretive tool. As described by other author: s, NIRS ability to quantify soil isolated analytes appeared highly analyte-dependant. NIRS predictions were satisfactory for clay, sand, organic C and total N, moderately satisfactory for CEC, Ca and Mg and poor for K, Na and pH. Soil chemical properties, structure parameters and microbial diversity were analyzed by principle component analysis (PCA) and confronted to NIRS spectra by coinertia analysis. Qualitative information provided by NIRS regarding soil chemical properties, structure and microbial diversity changes were satisfactory since all coinertia analysis were significant (Monte carlo test p-value <0.001) confirming the potential of the NIRS to evaluate soil chemical, physical and microbial fertility changes.

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Introduction to the NanoSIMS instrumentation in Soil science quantitative mapping of soil-microbe-plant interactions and elemental fluxes with 50nm resolution

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The NanoSIMS is an imaging mass spectrometer able to map lateral distribution of elements and isotopic ratios with a spatial resolution down to 50nm in fields of view between a few microns and one hundred microns. Up to seven masses, elements and isotopes, can be acquired in parallel.

The SIMS technique is based on the sputtering of a sample's surface by a focused beam of reactive Primary Ions (Cs⁺ or O⁻) followed by the mass over charge analysis of the ejected Secondary Ions using a Mass Spectrometer. The design of the NanoSIMS ion microprobe allowing keeping high sensitivity together with high mass resolution (to resolve mass interferences) and high spatial resolution will be reviewed.

The NanoSIMS first commercialized for the isotopic analysis of sub-micron extraterrestrial particles in the field of cosmochemistry has been successfully applied to material science, geology, cell biology [1] and more recently environmental microbiology [2].

The same strategy used for cell biology can be applied to soil studies when coupled with a stable isotope (i.e. ¹³C, ¹⁵N, ...) labeling strategy (incubation or pulse chase) the extraction of isotopic ratio (¹³C/¹²C, ¹⁵N/¹⁴N, ...) from small Regions Of Interest (ROIs) inside the image allows measuring quantitatively and at high lateral resolution elemental fluxes, interactions or competitions between cells, plants or other living organisms in their natural environment [3].

The method requires similar sample preparation as used for Electron Microscopy, generally a chemical fixation followed by resin embedding and polishing or sectioning. Thin sections allow correlative TEM imaging prior (destructive) NanoSIMS analysis, giving even higher spatial resolution. In addition the embedding resin provides an internal standard for isotopic ratios.

The NanoSIMS coupled with a strategy of stable isotope labeling appears as a new tool in soil science to help understanding elemental cycling (nitrogen, carbon, others), working at the cellular level.

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Local-Scale Distribution of Organic Matter Composition and Wettability at Preferential Flow Path Surfaces

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Surfaces of preferential flow paths in structured soils consist of clay-organic coatings (i.e., cutanes) on soil aggregates or linings on biopores (i.e., worm burrows and decayed root channels). The outermost layer of such surfaces is mostly covered by organic matter (OM). The composition of this OM finally controls wettability and sorption properties that are relevant for transport along the flow path. However, the local distribution of OM-properties along such surfaces is largely unknown because analyzes without disturbing the coating layer surfaces have not been possible to date.

The objective of this study is to compare the local 2D distribution of soil OM composition at intact aggregate and biopore surfaces with that of the wettability. The OM composition is determined using Fourier transformed infrared spectroscopy in diffuse reflectance mode (DRIFT) in terms of the ratios of CH/CO functional molecular groups. Intact surfaces of soil aggregates were scanned using a DRIFT mapping procedure in a 1 mm grid. Wettability was observed by contact angle measurements using a Goniometer with a high-speed camera. The aggregate sample surfaces were distinguished into regions of earthworm burrows, root channels, clay-organic coatings and uncoated regions. In contrast to the uncoated surface areas, organic coatings on worm burrows and root channels show relatively higher CH/CO-ratios that correspond with longer water drop infiltration. Both, the OM composition of coatings along preferential flow path surfaces and the water repellence are spatially variable at this local scale. The results indicate yet unknown implications for preferential flow and transport especially for reactive solutes.

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Next generation sequencing to determine the shaping factors of microbial communities in environmental samples

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The recent development of next generation sequencing brings new insight microbial ecology by allowing the identification of huge microbial diversity in environmental samples. By relating this diversity to soil physico-chemical properties it is possible to extract factors involved in microbial community structuring. By analysing bacterial and fungal diversities in different soil areas and different depths, the aim of the present study was to investigate and compare the distribution of these communities according to their habitat. Soil cores were harvested around the Lake Erken in Sweden from soils with different histories and covers (agricultural, conifer forest, flooded and unflooded soils, shore of the lake). DNA was extracted from the upper and lower organic layers as well as from the mineral layer of these soil cores and bacterial and fungal diversities were determined by 454 sequencing of 16S rRNA and ITS, respectively. Soil water, organic, C and N contents as well as pH were determined. A total of 650 000 and 350 000 sequences were retrieved for bacteria and fungi, respectively, and their analyses were performed using the RDP pipeline (<http://pyro.cme.msu.edu/>) for bacteria and using SCATA (<http://scata.mykopat.slu.se/?p=home>) for fungi. Preliminary results showed that abundance and diversity of bacteria and fungi varied greatly according to both depth and area. Further analyses should determine the major shaping factors responsible of these microbial distribution patterns in both horizontal and vertical gradients. This study takes part in the Uppsala Microbiomic center (UMC) project investigating the microbial communities and functioning along a gradient from terrestrial to aquatic areas.

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CO₂ uptake by soil chemoautotrophs identification, quantification and characterisation.

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Soil Organic Matter (SOM) is the most complicated biomaterial on Earth. It has been shown to contain significantly more carbon than is currently present in the atmosphere (approx twice as much). It has been recently reported that humic material in SOM is a highly complex mixture of microbial and plant biopolymers and not a distinct chemical fraction as previously thought. Furthermore, it has been reported that the microbial biomass contribution to SOM is not comprised of mainly humic materials and that in fact the contribution to SOM by soil microorganisms has been seriously underestimated. Therefore, the question arises if we underestimate microbial biomass in soil do we also underestimate carbon uptake by soil microbes? The presented material herein is part of a project to develop a methodology to combine ecological studies with molecular characteristics using soil chemoautotrophic bacteria in vivo and measurements of CO₂ uptake using a stable carbon isotope (¹³C). Soil microcosms were developed in an environmental incubation chamber under short term incubations (≤24 hr). Detection of the labelled biomass within the SOM fraction was performed using GCMS-IRMS. IRMS analysis revealed isotopic enrichment of lipids up to 91%, which can be directly affiliated to atmospheric CO₂ capture. High resolution infra-red detection of internal CO₂ concentrations indicate that maximum uptakes rates of 1574 mg CO₂/Ha/100 hr were incorporated into biomass. Complimentary analysis using ¹³C solid state HR-MAS-NMR confirmed enrichment had taken place leading to the detection of complex biomaterial such as carbohydrates and proteins. Preliminary identification of CO₂ assimilating microbes was performed using ultra-centrifugation stable isotope probing (SIP) to separate the ‘heavy’ labelled DNA fraction from the total DNA. The isolated ¹³C-DNA was then cloned into E.coli using standard molecular biological techniques and the identification of *Acidithiobacillus ferrooxidans* and *Thiobacillus denitrificans* was made by comparison to the BLAST DNA sequence database.

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Influence of Soil DNA Extraction Procedure to Assess Bacterial Diversity using Pyrosequencing of 16S rDNA

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During the last two decades, novel molecular and robust methods were developed that were well-suited to characterize soil microbial communities, as they provided access to previously hidden genetic resources. These methods were based essentially on soil DNA characterization and most efforts were devoted to optimize the soil DNA extraction procedure in order to obtain representative and suitable extracts for quantitative and qualitative characterization of microbial communities. Though several studies have evaluated the technical biases of these procedures to compare microbial abundance and community fingerprinting in diverse soils, the recent development of high throughput sequencing technology, which allow the scientific community to get hundreds of thousands of ribosomal sequences from a single metagenomic DNA, need to revisit our evaluation of soil DNA extraction efficiency to recover microbial diversity. Our study aimed at evaluating three soil DNA extraction procedures (two homemade protocols Gns-GII and SY3 and one commercial kit MOBIO) on seven contrasting soils for their efficiency (i) in recovering soil DNA and, (ii) in the detection of bacterial species richness and evenness estimated with pyrosequencing of 16S rDNA. The seven studied soils originate from the soil library of the French Soil Quality Monitoring Network (RMQS), which contains more than 2,200 soils representative of the pedologic, climatic and land use conditions encountered on the French national territory. Soils were chosen because of their contrasting pH, texture, carbon organic content and land-use characteristics, known to strongly influence microbial abundance and diversity. Significant differences were systematically observed between procedures with, in certain soils, 10 times more DNA recovered than in the other protocols. In the same way, significant differences in the number of taxonomic groups detected (between 2 and 21% at the genus level) were observed between Gns-GII and SY3 procedures and the lowest recovery systematically recorded for the MOBIO one. These differences were explained by a lower protocols efficiency to recover some major and minor phyla (such as Firmicutes or Crenarchaeota). Altogether, this study demonstrates the need to revisit the old bias known to evaluate and optimize soil DNA extraction procedure before analysis of microbial diversity by novel massive sequencing technology such as pyrosequencing.

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Session 3

Dynamics of pollutants in soil systems and bioremediation

Environmental behavior of natural soil nanoparticles and their impact on the mobility of PAHs in soils

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Nanoparticles in soils participate in essential ecological services, such as element cycling, sorption and transport of nutrients, organics and pollutants. Their impact is more significant than previously thought due to the special characteristics arising from their nanoscale size and large surface area, and this recognition gap may lead to a lack of understanding of their role in many important biogeochemical processes. In this paper, we focused on the aggregation of extracted soil nanoparticles (SNPs), as well as their transport and deposition behavior in porous media. In particular, we investigate how they influence the mobility of polyaromatic hydrocarbons (PAHs) in soil. Nanoparticles were extracted from soils under different conditions. A dynamic light scattering technique was used to monitor the time-dependent average hydrodynamic diameter of SNPs dispersed in aqueous solutions. Also, transmission electron microscopy was applied to visualize the aggregation of SNPs. Column experiments were performed to identify the mobility of SNPs in water-saturated quartz sand (300-355 μm) under physicochemical and hydrodynamic conditions simulating the actual soil environment. The results were qualitatively explained by Derjaguin-Landau-Verwey-Overbeek theory to explain the interaction between SNPs and grain media surfaces, as well as that among the population of nanoparticles. At soil conditions of high ionic strength and normal soil pH range, the life cycle of nanoparticles was generally short because they easily aggregated themselves or deposited on the surfaces of grain media. The significance of the transport of SNPs is that they serve as vectors for the transport of contaminants through soil, such as PAHs, a group of the most common soil pollutants. Adsorption of PAHs onto SNPs, and removal of PAHs from water-saturated quartz sand by eluting SNPs suspensions were both carried out to determine the impact of SNPs on PAH mobility. The study demonstrated that the apparent aqueous solubility of PAHs was enhanced by its sorption to the SNPs. However, this increasing trend declined as the nanoparticle concentrations increased, probably due to increasing nanoparticle aggregation/precipitation, inducing the removal of PAHs adsorbed on them from the aqueous phase. Also, the mobility of PAHs in soils was not obviously increased during the eluting processes, probably due to the transient existence of discrete SNPs before they aggregated or precipitated.

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Interactions of pathogens *Escherichia coli* and *Streptococcus suis* with clay minerals

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The adsorption of pathogens *Escherichia coli* and *Streptococcus suis* on clay minerals (montmorillonite and kaolinite) was investigated as a function of pH and ionic strength (IS) using batch studies. The adsorption isotherms of pathogens on clay minerals conformed to the Freundlich equation. *S. suis* was found to be more adhesive than *E. coli*, with calculated Kf values higher than those of *E. coli*. As for the examined two pathogens, their adsorption capacity on montmorillonite was greater than that on kaolinite. Increasing solution pH or decreasing IS (≤ 20 mM) resulted in decreased adsorption as a result of the decrease in the measured zeta potential of pathogens. This trend was consistent with predictions from classic Derjaguin – Landau – Verwey - Overbeek (DLVO) theory. Conversely, higher IS (≥ 50 mM) depressed pathogens adsorption, which suggested that an additional non-DLVO type interaction (electrosteric repulsion) occurred at higher IS due to the presence of extracellular macromolecules. This finding provides important insight into the pathogenic behavior in soil and associated environments.

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Microbes and Enzymes in Soil Bioremediation Problems and Solutions

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Soil environments have a high degree of chemical, physical and biological complexity that is difficult to measure and define. In addition, there are temporal and spatial discontinuities and chaotic events that make it very hard to provide generic solutions to soil remediation.

Successful soil bioremediation will depend on a large number of factors including the catabolic potential of the bacteria and fungi, their capacity to locate and access the xenobiotic, and the survival and scavenging properties of their extracellular enzymes. The mineralization of a xenobiotic will often require not just one genotype but a community of microorganisms, initially secreting a number of enzymes that can operate in concert to convert the target organic to soluble products that can then be recognised by the cell and transported into the cytoplasm. Many of the synthetic organics in polluted soils are hydrophobic, polymeric and even toxic to cells and these are constraints to uptake and metabolism that must be overcome for successful bioremediation. In addition, many persistent xenobiotics are associated to a greater or lesser extent with the soil clay and humic fractions reducing their accessibility to microbial and enzymatic attack; a property described as bioavailability. Successful soil bioremediation presumes that the target pollutants can be made bioavailable and that a competent community of microbial species either already exists and can be stimulated or that can be introduced and established (bioaugmentation). The molecular assessment of a soil's indigenous microbes, as a guide to rational remediation and the development of 'ideal' inoculant communities, will be discussed.

Increases in microbial numbers and metabolic processes in the root zone in comparison to the root-free soil are well known. There is evidence to suggest that certain plant species enhance the degradation of soil pollutants in contrast to those that have little or no effect; this is called rhizoremediation. Furthermore, the use of microbial inoculants with catabolic genes carried on transmissible plasmids and traits for rhizosphere competence offer considerable potential in circumstances where introduced strains only survive for a short period of time.

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Bacterial and Fungal Contribution to the Degradation of MCPA at the Soil-Litter Interface

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The detritosphere is an excellent model to study microbial-physicochemical interactions during degradation of the herbicide MCPA. Chlorophenoxy acetic acids have been among the most heavily used herbicides against dicotyledonous plants for around 50 years; they are model compounds for studying the degradation of chlorinated xenobiotics. Bacterial MCPA degradation is initiated by *tfdA* genes encoding a 2,4-dichlorophenoxyacetic (2,4)/alpha-ketoglutarate dioxygenase. *TfdA* cleaves the ether bonds of MCPA to produce 4-chloro-2-methylphenol (MCP). This intermediate can be degraded by chlorophenol hydroxylases encoded by *tfdB* genes to produce chlorocatechol. Much less is known whether fungi can metabolically or co-metabolically contribute to the decay of MCPA. We studied microbial degradation, microbial abundance of degraders, adsorption, desorption and transport of MCPA at a soil-litter interface. Isotopic data (¹⁴CO₂, ¹⁴C_{mic}, ¹⁴C-DOC, ¹⁴C_{Org}, ¹⁴C-MCPA, ¹⁴C in the leachate) and molecular data (*tfdA*, 16S rDNA and 18S rDNA sequence copy numbers) were used to improve our understanding the microbial regulation of MCPA degradation in this microhabitat. Transport of litter compounds was identified as important process, which might regulate the activity of the MCPA degrading community at the soil-litter interface. In addition, we were able to prove that bacteria as well as fungi make use of MCPA derived carbon using a newly established stable carbon isotope ratio method for phospholipid fatty acids. The increased bacterial and fungal MCPA degradation at the soil-litter interface can be explained by complex regulation mechanisms of MCPA degradation (1) At the cellular level, co-substrate availability and laccase abundance might be important regulators, and (2) at the microhabitat level, interaction between MCPA degraders and organo-mineral surfaces as well as transport processes might be important regulators.

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Modelling PAH dynamic during the remediation of contaminated soil through composting with organic wastes

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Composting may enhance bioremediation of PAH-contaminated soils by providing organic substrates that stimulate the growth of potential microbial degraders. An in-vessel composting-bioremediation experiment of a Chinese contaminated soil amended with fresh wastes was carried out. Four different experimental conditions were tested in triplicate during 60 days using laboratory-scale reactors Treatment S (100% soil), W (100% wastes), SW (soil/waste mixture) and SWB (soil/waste mixture with inoculation of degrading microorganisms). Dry mass loss, PAH concentration, biochemical quality of the organic matter, adsorption coefficients of PAH on organic matter and PLFA profiles were measured along the experiment. The dissipation of the 16 USEPA-listed PAHs was largely enhanced from no significant change to $50.5 \pm 14.8\%$ (for SW) / $63.7 \pm 10.0\%$ (for SWB). PLFA profiling showed that fungi and G- bacteria dominated at the beginning of experiment and were probably involved in PAH dissipation. The model COP-COMPOST, developed to simulate the behavior of organic pollutants during composting in interaction with organic matter, was applied to simulate this experiment. It includes 2 modules one for organic matter evolution and one for organic pollutants dynamic. The organic pollutants module simulates the organic pollutants mineralization and the evolution of their speciation. The model was first calibrated using experimental data of literature using a specific composting experiment of 4-L where ¹⁴C-labeled fluoranthene distribution among soluble, sorbed and non-extractable fractions was measured by extraction procedures. The model was then tested using these parameters to simulate the PAH bioremediation experiments. Finally, a sensitivity analysis of the model was conducted in order to evaluate the impact of microbial compartment number and the quality of organic matter on PAH dissipation. The results suggest that improving the composting process with optimal organic compositions may be a feasible remediation strategy in PAH contaminated soils.

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Do bacterial-mineral interactions affect pesticide degradation ? A case study with 2,4-D and *Cupriavidus necator* JMP134.

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A better knowledge of mechanisms affecting pesticides biodegradation and stabilization in soil is essential for predicting their environmental impacts. The activity of the microorganisms affecting pesticide fate is depending on their localisation into the soil and on the interactions with soils constituents. Thus, the adhesion of pesticide degrader bacteria to soil surfaces and the subsequent formation of biofilms may have important consequences on the fate of pesticides. In this study, *Cupriavidus necator* JMP134, a β -proteobacterium able to degrade a variety of chloroaromatic compounds was used as an experimental model to study the influence of a mineral phase on the degradation and the retention of the herbicide 2,4-dichlorophenoxyacetic acid (2,4-D). Bacterial cultures were incubated in a mineral liquid medium containing 2,4-D as sole carbon and energy sources, with or without sand. At 5 sampling dates, bacterial and 2,4-D concentrations were measured by spectrophotometry and the evolution of bacterial biofilms visualised by low temperature scanning electron microscopy (LTSEM). We used ¹³C labelling to estimate the amount of ring and chain carbon from the 2,4-D molecule mineralised and assimilated by the biomass. The incorporation of ¹³C-2,4-D into the microbial biomass was followed at the molecular level by monitoring the ¹³C enrichment of FAME. When sand was added to the liquid medium, up to 90% of bacteria were fixed to the mineral phase after 1 day. LTSEM observations showed that biofilm structures appeared after only 2 days. After 10 days, the residual amount of 2,4-D was 25% lower and the CO₂ evolved 15% higher in sand microcosms. Measurement of ¹³C content of in CO₂ and FAME showed that no significant change in the metabolic pathway occurred. The sessile mode of life of *C. necator* JMP134 did improve 2,4-D removal from water by increasing both its mineralisation and its retention within the biofilm. These results suggest that interactions between minerals and microorganisms, and the nature of the microbial habitat, should be taken into account for modelling pesticide fate in soils.

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Bioremediation of PCP contaminated soil by *Byssochlamys nivea* and *Scopulariopsis brumptii*

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Pentachlorophenol (PCP) is a man-made chemical used as a wood preservative. It is very toxic to mammals, plants, and many microorganisms. Moreover, PCP is a persistent compound since it is recalcitrant to degradation because of its stable aromatic ring structure and high chlorine content. The use of bacterial and fungal strains isolated from contaminated sites represents a good approach to solve serious PCP pollution problems. In fact, despite its persistence, microorganisms have been identified as resistant to relatively high PCP concentrations and able to metabolize it to carbon dioxide and chloride.

The main goal of the current work was to evaluate the capability of two fungi, *Byssochlamys nivea* and *Scopulariopsis brumptii*, to remediate a soil artificially contaminated with PCP. These fungi isolated in a previous study from PCP polluted soils were inoculated in a different soil spiked with 12.5 and 25 mg l⁻¹ PCP. During 28 d-incubation time residual PCP concentration, some enzymatic activities (dehydrogenase and fluorescein diacetate hydrolytic activity), biomass carbon and soil respiration were weekly evaluated.

Although a decrease of soil biological properties was observed over time, the PCP removal reached 75 and 65% in soil samples spiked with 12.5 mg l⁻¹ and 25 mg l⁻¹ PCP, respectively. A very interesting result was obtained when the contaminated soils were inoculated with both *B. nivea* and *S. brumptii* the contaminant was removed by 80 and 95% when the initial PCP concentration was 12.5 mg l⁻¹ and 25 mg l⁻¹, respectively. This behavior could be indicative of synergic effect arisen by degradative pathways of both fungi.

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Session 4

Soil microbial activity and soil function

Diversity and interactions in bacterial communities involved in mineral weathering, iron mobility and ferrous toxicity in rice fields of tropical ferralsol-gleysol sequences.

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In soil sequences of Ivory Coast, grading from ferralsol (ferrallitic soils) to paddy soils (gleysol - rice fields), leaching and redistribution of iron occur from the plateau zone to the lowland paddy soils, and through the soil profiles. High ferrous iron content of soil solutions can be responsible of toxicity toward rice. To progress in the knowledge of iron release and cycling of elements, characterization of soils and soil solutions and experiments have been done. Experimental conditions close to some of the main environmental parameters allow to study (1) the relation between soil organic matter biodegradation and the reduction-dissolution of iron and associated elements (2) the functions and structures of cultivable and non cultivable bacterial communities involved.

The results show leaching and redistribution of iron in the soil sequences and soil profiles and seasonal releases of ferrous iron, sulfate, organic acids from fermentation origin in the soil solutions. Such results suggest different bacterial activities which were verified in experiments. Soils provide bioavailable iron mainly as reducible ferric iron and biodegradable natural organic matter to support very efficient iron reducing bacterial (IRB) activities. Significant positive correlations were observed between biodegradation-mineralization of natural soil organic matter and bacterial reduction-dissolution of iron, explaining high contents in the soil solutions. Various bacterial communities (cultivable and non cultivable bacteria) have been observed using classical and molecular biology methods (PCR-TGGE). Among these communities, a large diversity of bacteria occurred, representing different complementary metabolic pathways in the cycling of carbon, iron, sulphur, nitrogen, in different environmental conditions: fermentative facultative iron reducers (*Bacillus*, *Clostridium*...), iron respiring (*Geobacillus*, *Alkaliphilus*...), sulphur oxidizers (*Thiobacilli*...), sulfate reducers (*Desulfovibrio*...). They are heterotrophic, autotrophic, aero anaerobic, anaerobic and present evolution in the structures of the communities, indicating a large diversity and adaptability in their activities. They are involved in the reduction and dissolution of iron in different environmental conditions, in the cycling of elements and in the coupling of biogeochemical cycles.

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Granite dissolving bacteria from the Damma glacier forefield

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Several bacterial strains isolated from granitic rock material in front of the Damma glacier (Central Swiss Alps) were shown (i) to grow in the presence of granite powder and a glucose + NH₄Cl minimal medium without additional macro- or micronutrients and (ii) to produce weathering-active agents. In particular, four bacterial isolates (*Arthrobacter* sp., *Janthinobacterium* sp., *Leifsonia* sp. and *Polaromonas* sp.) were weathering active. In comparison to abiotic experiments, the presence of these strains caused a significant increase of granite dissolution (as measured by the release of Fe, Ca, K, Mg, and Mn). These most promising weathering-active bacteria exhibited four main features rendering them more efficient in mineral dissolution than the other investigated isolates (i) a major part of their bacterial cells were attached to the granite surfaces and not suspended in solution, (ii) they secreted the largest amounts of oxalic acid, (iii) they lowered the pH of the solution, and (iv) they formed significant amounts of HCN. As far as we know this is the first report showing that the combined action of oxalic acid and HCN appears to be associated with enhanced elemental release from granite, in particular of Fe. This suggests that extensive microbial colonization of the granite surfaces could play a crucial role in the initial soil formation in previously glaciated mountain areas.

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Seasonal dynamics of Al-bearing secondary minerals in an acidic forest soil: influence of Norway spruce roots

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In acidic soils, aluminum plays a key role in pedogenetic processes; however, the seasonal evolution of Al in solid phase is little documented. The aim of the present study was therefore to assess the seasonal dynamics of Al secondary minerals in three soil compartments (Bulk, B; Rhizosphere, R and Rhizosphere Interface, RI) in an acidic soil of a temperate forest. The soil sampling was performed under a stand of 31-year-old Norway spruce in four months (November, February, May and August) and at three depths (0-3, 3-10 and 10-23 cm). Aluminium extracted by oxalate (Alo) and by tri-citrate (Alc) were used to determine in the fine earth fraction (< 200µm) the short range ordered Al-bearing mineral (Alo) and well crystallized Al oxides and hydroxides (Alc-Alo). The amounts of Alo and Alc increased significantly with depth to form an accumulation horizon in the soil profile, indicating a trend towards podzolic development in this soil. Generally, a decrease of Alc was observed between the bulk soil and root surface (B > R > RI), suggesting that the rhizosphere did not favour the precipitation of Al-bearing secondary minerals. Interestingly, the results of this study revealed contrasted seasonal dynamics of both, Alo and Alc-Alo, in the soil profile. Indeed, in the three soil compartments (B, R and RI), Alo varied significantly with the seasons in the surface horizon (progressive increase of 40 to 50 % between November and August); whereas Alc-Alo varied significantly with the seasons in the 10-23 cm horizon (drastic decrease of 50 to 70% between February and May). These results thus showed that Al precipitated progressively in poorly crystallized compounds between autumn and summer in the surface horizon; whereas the dissolution of crystalline Al forms occurred between winter and spring in the 10-23cm horizon. Furthermore, complementary analyses showed that a large part of these Al-bearing secondary minerals was bound to organic matter. This study thus reveals that the amounts of Al-bearing minerals vary strongly with the seasons in the bulk soil and the rhizosphere of Norway spruce, suggesting that the precipitation and dissolution processes influence during the year both forms of Al-bearing mineral (i.e., poorly crystallized and well crystallised forms).

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Bacterial action as an alteration agent of recent pyroclastic materials from Mt. Talang and Mt. Merapi, Indonesia

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Initial stages of rock alteration in the biosphere are affected by living organisms such as bacteria, fungi and lichens. All of these microorganisms are known to have an impact on the chemical stability of silicate minerals. It has been indicated that bacterial action is mineral selective and the effect on the dissolution of minerals influenced by temperature, pH and the type of organic matter available. Although numerous studies have been carried out to better understand the interaction between plants and silicate dissolution by bacteria, plant nutrients release from pristine pyroclastic materials is not yet studied.

West Sumatra and central Java in Indonesia are influenced by volcanic activities. Mt. Talang, in West Sumatra erupted in 2005, while Mt. Merapi in Central Java erupted in 2006. During the volcanic eruptions, pyroclastic materials were blown up into the atmosphere and later were deposited back on the earth surface. These new materials, consisting of abundant easily weatherable minerals, are considered important parent materials for soil formation. Soon after the eruption pyroclastic materials were collected, stored in seal-tight plastic containers and transported to laboratory.

A series of dissolution experiments was performed in order to assess the role of bacteria in dissolution of cations and anion from pyroclastic in a closed-batch reaction vessel by continuous shaking in the dark at room temperature in the presence of bacteria. The bacteria were isolated from surface volcanic soils of Mt. Talang. The sequencing of DNA genes encoding portions of bacterial 16S rDNA was used in species determination of bacterial. The sequence homology of the bases determined was then searched in the DNA published database using BLASTN program. The clone frequency indicated that *Bacillus cereus* and *Bacillus thuringiensis* were dominant.

Solution leachates were collected accordingly. The amounts of dissolved cations and anion from pyroclastic materials and leachate pH were determined after 3 hours, 3, 7 and 15 days, respectively. Different behavior in leachate pH was observed. The leachate pH from Mt. Talang pyroclastics decreased with time by 0.45 units, but the leachate pH of the Mt. Merapi pyroclastics increased by 0.54 units after 15 days. The release of cations from both types of pyroclastics was in decreasing order of K>Fe>Ca>Mg. The rate of initial dissolved P was high and dropped to about 20% after 15 days in pyroclastic material...

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Effect of organic amendments and promoting bacteria on root density in table grape

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The Limari Valley is one of the most important producing areas of table grape in Chile. In this zone, soils are predominantly Alfisols and Inceptisols with low organic matter (OM) content. The application of OM sources is a common practice intended to stimulate root and plant growth. The main objective of this research was to evaluate the effect of the application of organic amendments on some soil quality indicators and agronomic variables in table grape cultivated on typical soil of the Limari valley. The experiment was performed on 50-L pots (one plant per pot as experimental unit). One-year old nursery plants (var. Thompson seedless -no rootstock-) were grown for 8 months. Two organic sources (mature compost from grape pomace and liquid humic acid) in presence of (chemical) fertilization were evaluated. Compost, 500, 1000 and 2000 kg C ha⁻¹; liquid humus (LH), 100, 200 and 400 kg C ha⁻¹. Both products at all C rates were evaluated in the presence/absence of a microbial inoculant with plant growth promoting rhizobacteria; besides, compost and LH at their maximum C rates were evaluated in absence of fertilization. Adequate controls were also included, totalizing sixteen treatments that were arranged with 6 replications. Evaluated variables included soil chemical (N-NO₃, N-NH₄, Olsen-P, pH, EC), microbial (cfu g⁻¹ of fungi, yeasts, actinomycetes and phosphate solubilizers), biochemical (urease -μg NH₄ g⁻¹ h⁻¹, acid and alkaline phosphatase and β-glucosidase activities -μg para-nitrophenol g⁻¹ h⁻¹), and agronomic ones (root dry matter -g- [RDM], root density -g cm⁻³ [RD], stem diameter -cm [TD]). Results indicated that applications of compost promote the enzymatic activity involved on P and C dynamics and probably on N mineralization. The compost used in this study presented a content of humic+fulvic acids close to 10%, while in the LH it was up to 50%. However, LH applications reduced the microbial activity (p<0.05). Thus, a better answer in root growth was attained by using compost. Compost application resulted significantly (p<0.01) better than LH to promote RDM (57.27±24) and RD (1187.19±140), and increasing the activity of alkaline (325.93±234.2) and acid phosphatase (228.6±133), and β-glucosidase. No correlations between the microbial populations and evaluated variables were found, but the positive effects could be due to stimulation of indigenous populations of soil and production of root stimulating substances.

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Tiered approach to investigate the possibilities for growing crops for consumption on potentially contaminated land

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With a fast growing world population (from currently 6.9 billion up to 7.5-10.5 billion in 2050) the world's crop production must increase in the coming decades. As a consequence, there will be an increasing pressure on land for growing consumption crops (next to energy crops). One of the limitations, however, is soil contamination. Therefore, it is useful to have a decision framework which focuses on the possibilities for growing consumption crops on potentially contaminated land. During the last 30 years risk-based contaminated land management developed from a conservative multifunctional approach into a pragmatic approach in which protection of human health goes hand in hand with cost-effectiveness.

In this project a pragmatic procedure has been developed to investigate the possibilities for growing crops for consumption on potentially contaminated land. Under the principle "simple when possible, complex when necessary" this procedure follows a tiered approach. This tiered approach is laid out as follows. Tier 0 concerns a preliminary qualitative evaluation of the possibilities for experiencing adverse human health effects due to crop consumption. In Tier 1 the actual total soil concentrations (average or relatively high values) are compared with a Critical soil concentration. These Critical soil concentrations have been derived on the basis of a conservative exposure scenario. Tier 2 offers the possibility for a detailed assessment of the site-specific risks on the basis of calculation. Obviously, the site-specific calculation of the contaminant concentration in crops differs for metals (Freundlich-type crop - soil relations including total soil concentration and the major soil properties), other inorganic contaminants (passive uptake) and organic contaminants (partitioning of contaminants between pore water and roots and subsequently translocation to the upper plant parts). Finally, in Tier 3, a standardized measurement protocol is used, which allows for sampling of a significant number of representative crops in the field, for which the edible parts of the plants are treated in the laboratory in analogy with standard kitchen preparation. Subsequently, the measured concentration can be used in an exposure calculation and, when appropriate, compared to acceptable concentrations in crops. An example will be shown for with cadmium contaminated land.

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Increasing demand for biomass energy How does short rotation coppice impact soil properties in the medium and long-term? A case study in young soils in the Marchfeld, Lower Austria.

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EU climate policies focus on a reduction of CO₂ emissions and an increase of the share of renewables to 20 % until 2020. Bioenergy is very important and accounts for more than half of the renewables today. The biomass comes from waste- and by-products from agriculture and forestry as well as dedicated bioenergy crops. Perennial crops, such as short rotation coppice and miscanthus, are considered as extensive low input crops. Nevertheless, little is known about short and long-term changes to soil properties caused by different land use and soil management intensities, e.g. by perennial bioenergy crops.

The aim of this study was to assess the influence of a 14 year old poplar and willow short rotation coppice and a miscanthus plantation on the soil of a previously conventionally used agricultural field. Additionally, an agricultural field, a grassland site and a semi-natural forest with similar soil age and soil properties were studied. The research area is situated in the continental climate region (average annual temperature 9 °C, average annual precipitation 540 mm) in the Marchfeld east of Vienna, Austria. The soils in the area formed on fine Holocene sediments of the Danube River, which have created relatively homogenous chemical and physical soil conditions. Soil dating resulted in similar soil age at the studied sites. In 2000 and 2010 samples were taken from the upper soil horizon (0-40 cm) for detailed nutrient and soil analyses. Further soil characterisation was also carried out using samples from the lower soil layers, taken to a depth of 200 cm. The results revealed different soil characteristics typical for each land use, as well as changes to soil properties on specific sites. For example, a change in the organic carbon content was detected on the short rotation coppice sites (e.g. increment of organic C on the poplar site 0.07 %/year). This may have been caused by increased litter inputs from annual leaf fall and the dense ground vegetation. Still, on the agricultural field, the organic carbon increment was slightly lower and amounted to 0.05 % showing a non-equilibrium state of the soil organic matter in the young alluvial soils. The root mass distribution in the upper and lower soil layers was another indicator clearly depicting the influence of the different land uses, ranging from 0.45 t dry mass/ha on the agricultural field to 11 t dry mass/ha on the short rotation coppice stand, and even 19 t dry mass/ha on the forest site.

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Impact of clay minerals and iron oxide on microbial diversity in two Chinese soils

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The impact of kaolinite (K), montmorillonite (M) and goethite (G) on the microbial communities in Red and Brown soils, which were collected from southern and northern China respectively. The soils were amended with each of the minerals at ratios of 5% (dw/dw) and 15% (dw/dw). The microcosms were incubated for 3~6 months in greenhouse. Soil biochemical properties and microbial communities were assessed. For Red soil, mineral treatments decreased dramatically the numbers of bacteria, actinomycetes and fungi when incubated for 3 months. However, a strong recovery of soil microorganisms was observed 6 months after the addition of minerals. The effect of minerals on microbial composition in Brown soil varied with the types of microbes. Introduction of K and G enhanced the proliferation of bacteria and actinomycetes in Brown soils, while M showed a negative effect. Fungi seemed not to be affected by the minerals. Soil microbial biomass C was inhibited by mineral amendments in both soils for a 3-month incubation, but was significantly enhanced in the counterparts after prolonged incubation for 6 months. Ordination of the physiological (BIOLOG) data separated the microbial communities into different clusters, determined by the minerals types and concentration. For Red soil, amendments of G at the rates of 5% and 15% formed distinct communities from all the other treatments which fell into the same cluster. Brown soil amended with higher concentration of mineral formed contrasting microbial communities from those amended with lower concentration. Hierarchical analysis of 16s-rDNA based DGGE patterns also identified a primary effect of mineral type and concentration along the soils and incubation time, corresponding to the data of BIOLOG Ecoplates. These results suggest that soil microbial diversity can be significantly affected by soil minerals depending on the type and concentration. The same mineral may have varied impact on the microbial communities in different soils. Moreover, incubation time must be taken into account when investigating the shift of microbial community.

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Effect of environmental conditions, soil type and ligninolytic substrate on biological activities in biomix of biobeds

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Pesticides play an important role in the success of modern farming and food production. However, surface and groundwater can be contaminated due to their inadequate management. Biobeds are low-cost and low maintenance biological systems developed in Sweden and used to reduce point source water and soil contamination by pesticides. In this study the effect of different types of soil, composting time of the biomix and incubation temperature on biological activities in the biomix of biobeds system were evaluated. The biomixes were established with peat, 3 different soils (clay soil, sandy soil and trumao soil) and 3 lignocellulosic materials (wheat straw, pine sawdust and barley hulls) and mixed in different volumetric proportions. The soils were chemical and physically characterized and lignin and cellulose content were determined in all lignocellulosic materials. The biomixes were incubated at 10, 20 and 30° C. Periodically; samples were taken at 0, 15 and 30 days of incubation to evaluate biological activities (fluorescein diacetate hydrolysis and ligninolytic activity and CO₂ evolutions). The results showed that trumao soil has a higher content of organic matter (15.7%) compared with clay soil (3%) and sandy soil (2%). Lignin and cellulose content were higher in pine sawdust (20.6 and 54.3% respectively) compared with barley hulls (2.4 y 9.6%) and wheat straw (9.9 and 41.8%). The biomixes with more organic matter content were composed with clay soil and trumao soil and these values were increased when barley hulls or pine sawdust were added to the biomix. FDA hydrolysis was increased at 20° y 30° C when wheat straw and barley hulls were present in the biomix (between 4 and 6 µg g⁻¹ h⁻¹). Similar results were found in the CO₂ evolution; however the highest values were determined in the trumao soil. The ligninolytic activity was higher at 20 y 30° C (between 0.2 and 0.4 U L⁻¹), except for the biomixed composed with barley hulls where higher activities were determined in the biomixes incubated at 10°C. Therefore, the biological activities were highest in biomixes composed with clay and trumao soils and these were affected by the temperature more that for the incubation time. All lignocellulosic material stimulated both ligninolytic and FDA activities, but the highest values were found in the biomixes composed with barley hulls. Acknowledgements Financed by Fondecyt 1090678 and Fondef D09R1006 projects

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Investigation of the P solubilising effect of phosphate solubilising bacteria

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As a result of decades of excessive phosphorus fertilization, most acid sandy soils in Flanders (Belgium) and the Netherlands are phosphorus (P) saturated. This saturation entails a risk of significant P leaching to groundwater, and therefore very strict P fertilizer restrictions are enforced in these areas. One of the strategies to reduce the P concentration in these soils is through P mining by crops. However, despite the large P concentrations, the efficiency of mining rapidly decreases over time because most P is not directly plant available. Phosphate solubilising bacteria (PSB) transform unavailable P into plant available forms, and could thus prove to be very useful even in P saturated soils under severe fertilization restrictions, namely to increase the P mining efficiency. Until now, PSB have never been tested in such conditions, and therefore the goal of this research was to investigate the potential of PSB for increasing P extraction in conditions of high total P content.

Five PSB species, namely three *Bacillus* and two *Pseudomonas* species, were selected. In a first experiment they were tested on several growth media with different amounts and kinds of insoluble phosphate such as FePO_4 , AlPO_4 or CaPO_4 . This was done to check the growth ability of the PSB and their P solubilising potential under completely controlled conditions. The colony growth after 14 days of inoculation showed that all five bacteria were able to grow on each of the tested growth media. For the second experiment the bacteria were brought in a more realistic environment, namely in quartz sand with a nutrient solution that supplied all nutrients for the bacteria except P. The P was again provided in an insoluble form as FePO_4 , AlPO_4 or CaPO_4 . The water soluble P ranged from 3.2 to 6.9 and 29.0 to 40.7 mg kg⁻¹ sand for the insoluble Al-P and Fe-P treatments respectively. *Pseudomonas putida* and *Bacillus brevis* perform best as PSB in high P conditions where the P is fixed with Al or Fe, which is the case for the acid sandy soils in Flanders.

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Effect of long-term fertilization on microbial community structure as a soil quality indicator in rice paddy soil

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The effect of long-term fertilization on soil biological properties and microbial community structure in the plough layer in a rice paddy soil in southern Korea were investigated in relation to the continuous application of chemical fertilizers (NPK), straw based compost (Compost), combination these two (NPK + Compost) for last 40 years. No fertilization plot (Control) was installed for comparison. Though fertilization significantly improved rice productivity over control, the long-term fertilization of NPK and compost combination was more effective on increasing rice productivity and soil nutrient status than single application of compost or chemical fertilizer. All fertilization treatments had shown significant improvement in soil microbial properties, however, continuous compost fertilization markedly increased soil enzyme and microbial activities as compared to sole chemical fertilization. Results of microbial community structure, evaluated by EL-FAME (ester-linked fatty acid methyl esters) method, revealed big difference among Control, NPK, and Compost. However, both Compost and Compost+NPK treatments belonged to the same cluster after statistical analysis. The combined application of chemical fertilizer and organic amendments could be more rational strategy to improve soil nutrient status and promote soil microbial communities than the single chemical fertilizer or compost application.

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Influence of clay microstructure and organic matter on chlordecone sequestration in volcanic soils .

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Our study is related to the pollution by a persistent chlorinated hydrocarbon pesticide (chlordecone) in a tropical context. Chlordecone is a very tough pesticide which was used from 1971 to 1993 mainly for the control of the banana weevil in French West Indies. Chlordecone pollution is now diffuse becoming new contamination source for crops and environment. Previous studies have shown that andosol sequester chlordecone and it is assumed that the higher chlordecone content in andosols is the consequence of a high organic matter concentration thanks to the strong affinity of chlordecone for organic matter. However andosols contain amorphous clays (allophanes), issued from the transformation of volcanic materials. Allophanes present completely different structures and physical properties compared to usual clays. The clay microstructure could be an important physico-chemical characteristic governing the fate of the pesticide in the environment. In this study we compare the effect of these two parameters organic matter concentration and allophane microstructure. We show that allophane clay retains more pesticides than halloysite independently of the organic matter content. We also analyze the transfer to root vegetables cultivated in andosol and nitisol. The mean transfer rate to vegetables was proportional with the chlordecone soil content and varied by a factor 2-4 from between andosol and nitisol. Thus soil type had a great effect on the chlordecone availability in soil solution and its translocation into roots. Halloysite have a classical layer structure (in the range of a few microns) but we demonstrate the fractal structure of the allophane aggregates, at the nano scale between 5 nm to more than 100 nm. We show that a correlation exist between the allophane fractal structure and the larger pesticide content in allophanic soils. The specific physical properties leading to low transport properties could explain the higher ability to retain pesticide compared with nitisol. So, allophanic soils could be highly polluted but less contaminant for crops and environment because of this microstructure trapping effect. We also measured the effects of added composts on chlordecone lability and transfer rate from soil to plant. 3 months after incorporation the chlordecone sequestration in soils increase by a factor 5-10 showing that the two parameters soil microstructure and organic matter concentration control the chlordecone retention in contaminated soils.

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Control of copper impact on bacterial community by microscale localisation of microorganisms and added copper and organic matter in a vineyard loamy soil

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The effect of the soil organic status (SOS) on the dynamics and impact of a copper contamination was investigated in a coupled field and mesocosm study with a loamy vineyard soil that had been amended with conifer compost (CC) or not amended (NA) during a previous long-term field experiment. Soil mesocosms were contaminated at 240 mg Cu kg⁻¹ and incubated for 24 months. Cu distribution and dynamics were assessed in the solid matrix at the microscale by size fractionation of soils and in the soil solution by measuring total and free exchangeable copper concentrations (Cu²⁺). Copper bioavailability, CuBio, was also measured with a whole-cell biosensor. The impact of copper on soil bacterial community was evaluated through the monitoring of the amount of copper-resistant bacteria and through the variations in bacterial community structure using ARISA (Automated-Ribosomal-Intergenic-Spacer-Analysis).

Results showed that copper distribution, speciation and bioavailability are strongly different in the NA and CC soils, demonstrating that the organic status of soils largely controls the solid and liquid speciation of copper as well as its availability to microorganisms. Cu was shown to be dominantly distributed in the smallest size fractions (<20µm) of both control and amended soils and also in the coarser fraction (>250µm) of the CC soil. The coarser and finest size fractions of the soil are also the ones that release more Cu²⁺ and CuBio, explaining thus the important amount of Cu-resistant bacteria inhabiting these fractions and the differentiated temporal impact on the structure of soil bacterial community. The distribution of cultivable bacteria varied strongly between the two soils and was found to be well correlated with the distribution of added OM that controls thus bacterial community structure. The preferential impacts of copper observed in the smallest size fractions of the non amended soil demonstrate that copper toxicity and impact is also controlled by the reactivity of the soil fractions. This reactivity controls especially the release and the liquid speciation of Cu and thus bacteria-metal contact.

A clear relationship between copper speciation, bioavailability, distribution and impact was established in the present study and will permit better predicting the fate and impact of metals in soils, by accounting for microscale control of metal impact

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Effect of nitrogen and phosphorous fertilization on phosphatase and urease behavior in a Perennial Ryegrass rhizospheric soil

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In intensive pastures of Southern Chile, farmers apply large amounts of phosphorus (P) and nitrogen (N) to achieve the optimum dry matter yield. Though, in general the effect of N and P fertilizers on enzymatic reaction has not received major attention in Chile. In our country, grassland systems are commonly fertilized using urea at N supply ranging from 45 to 300 kg N ha⁻¹. The nutrient dynamics in soil-plant rizosphere system depends on the fertilization rate and the environmental condition. The aim of this work was to obtain complementary studies about the P and N dynamics in the rhizosphere under acidic conditions on phosphatase, and urease activities and N mineralization in an Andisol of Southern Chile. Ryegrass pastures were established in an Andisol belonging to Freire Serie on March, 2009 in the Maquehue Experimental Station of the Universidad de La Frontera. Four N doses (0, 40, 80 and 120 kg N ha⁻¹ as urea) were applied in combination with four P doses (0, 80, 160 and 240 kg P₂O₅ ha⁻¹ as triple superphosphate) in triplicate plots. In the soil samples obtained during 2009-2010 soil pH, Olsen-P, N-NH₄⁺ and N-NO₃⁻ (in soil and in leaching) and soil urease and phosphatase activity were evaluated. The soil pH increased after N fertilization (April, 21) from pH 5.3 to 5.7 and thereafter it returned to original values (5.4). Later, pH values were maintained constants or slightly increased according to natural variation. Olsen-P increased as P fertilizes rates increased, but it also appeared to return to its original values (around 18 mg P kg⁻¹) and showed no significantly differences with the treatment because of high P fixation and P uptake by plants. On the other hand, urease activity increased in Spring and Autumn seasons ranging from 40 in winter time to 290 µg g⁻¹ h⁻¹ in Spring time. After urea application, urease activity increased with N doses in all P treatments but also increased with P supplied. We observed an important effect of P fertilizer on urease activity and consequently an increment in N-NO₃⁻ in the soils. Nitrification process increased N-NO₃⁻ concentrations about 110 mg N kg⁻¹, meanwhile N-NH₄⁺ was kept around 18 mg N kg⁻¹. N-NH₄⁺ losses decreased as P rate fertilizer increased, while N-NO₃⁻ losses increased, because nitrification increased by P supplied. The phosphatase increased in Autumn season as N dose increased with P supplied.

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Session 5

Organo-mineral interactions in soils

Fate of functional groups of amino acids in soil assessed by position-specific labelling

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Transformation of low molecular weight organic substances (LMWOS) in soil is one of the most important processes in the turnover of organic matter as all substances pass the stage of LMWOS during decomposition. Sorption to the soil mineral surfaces is one of the main processes influencing these transformations. We used a unique feature of isotope applications – the position-specific labeling – to get a closer look on the mechanisms of amino acids transformation after their sorption in soil.

We assessed short-term transformations of the amino acids by mixing position-specifically labeled ¹⁴C-alanine with soil and measuring the ¹⁴C-activity in the supernatant at increasing time steps. In addition we sorbed alanine to the surfaces of goethite, hematite, kaolinite, bentonite and charcoal and mixed these adsorbents to the soil. The dynamics of desorption of the alanine and microbial utilization of C from its functional groups was traced during 3.5 days.

Sorption as well as desorption occurred as a whole molecule, whereas C from different positions of alanine showed different liability to microbial utilization. Microorganisms preferentially mineralize the C1-position, whereas C2 and C3 were mainly incorporated into microbial biomass. The type of adsorbents has a significant influence on the degradation kinetics of the sorbed alanine. Irrespective of the sorbent the carboxyl group (C1 position) is mineralized fastest, but the relative proportions of the mineralization of the C2- and C3-positions differ dependent on the adsorbent. These results indicate that the sorption mechanism affects microbial uptake and utilization of amino acids on a submolecular level. Desorption experiments revealed that intact alanine was mainly bound by cation exchange (by NH₂-group), whereas its degradation fragments and microbial transformation products show a higher contribution of ligand exchange or are irreversibly bound. This is one of the molecular mechanisms leading to stabilization of amino acid C in soils.

We showed that the application of position-specifically labeled substances opens new ways to investigate step-by-step transformations of LMWOS in soil. The transformations of single C atoms and corresponding functional groups allow conclusions about the interactions of LMWOS with mineral surfaces and the consequences for microbial transformations and thus improve our understanding of soil C fluxes.

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Effect of hydrofluoric acid hydrolysis on organo-mineral complexes (Cambisol and Andosol, La Réunion Island)

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Interactions between organic matter (OM) and mineral phases represent a fundamental mechanism of carbon (C) sequestration in soils. They form organo-mineral complexes, which prevent a rapid OM biodegradation. The densimetric separation technique enables an effective isolation of the different types of organo-mineral complexes in a soil. However, OM analyses present in these organo-mineral complexes are limited since C content are really low (< 10 mg of OM / g of soil) and mineral phases make direct studies of OM difficult.

Previous studies showed that hydrofluoric acid (HF) hydrolysis is an effective treatment for OM analyses since mineral phases are dissolved and then samples are enriched in C. Nonetheless, no study was directly made on organo-mineral complexes.

The main objectives of this study were to determine effects of HF hydrolysis on organo-mineral complexes and to establish the best treatment for OM analyses. After the densimetric separation, we used HF hydrolysis on two soils with different mineralogy an hydric Andosol and an haplic Cambisol (La Réunion Island), which were respectively mainly composed of poorly crystallized aluminosilicates phases and halloysite, and they were also both composed of iron oxides. We choosed three HF concentrations (2, 5 and 10%-HF) and four time contacts (1, 2, 4 and 6 times 2 h).

Mineral loss reached 94 % for both soils with higher treatments. Aluminium and silicium compounds were strongly dissolved after the first treatments, while iron compounds decreased slower according to the increasing of HF treatments. XRD analyses confirmed the rapid dissolution of halloysite, gibbsite and quartz with regards to iron oxides. For the organo-mineral complexes of the Cambisol, C enrichment reached 6.7, but C/Fe ratio (< 2) seemed to be still too low for an exploitable signal with ¹³C NMR. For the organo-mineral complexes of the Andosol, C enrichment (4.6) and C/Fe ratio (>13) allowed acquiring an effective signal with ¹³C NMR for OM qualitative analyses. However, aluminofluoride neofomed compounds appeared with the higher 10%-HF treatments for both soils. To conclude, this study bring to light that it is essential to adapt HF hydrolysis according to the mineralogy of each soil.

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Influence of polymeric coating on particle adhesion measured by hydrodynamic detachment

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Bioadhesion is an elementary process, involved in biofilm formation. Bioadhesion is mainly determined by the hydrophilic hydrophobic balance of cell surfaces, that governs the interactions with the environment. It is most often characterized by a number of adhesive cells per unit of surface. In this work, we develop an hydrodynamic method to investigate the role of polymeric coating on the adhesive forces of model particles. To that intend, both Brownian and no Brownian particles were used. There were deposited onto the internal surface of a parallelepiped glass cell and then submitted to increasing laminar flows. The adhesive force was related to the hydrodynamic force required to detach 50% of the initially attached beads. Results showed that neutral polymers of high polymer weight, sorbed on a single surface (particle or glass cell), had little effect on the adhesion of small particles. On the contrary they greatly enhanced adhesion of bigger ones. This discrepancy is attributed to the low affinity of neutral polymers towards both surfaces and to the contribution of gravity in the case of beads, that increase the contact surface. Effect of neutral polymers increases with the molecular weight of polymers. When coating involved polyelectrolytes, adhesive force is increased in a drastic way, even with copolymers of low cationicity rate (5 %) showing the efficiency of electrostatic attractions in the adhesion process. When copolymers were adsorbed on both surfaces (particles and planar surfaces) the adhesive force exhibited a maximum at intermediate coverage of particles. This fact is related to the optimum of flocculation classically observed in flocculation of suspension by polymers. The experimental tool, being developed, has proven to be useful to measure the effect of macromolecular parameters in the efficiency of adhesion such as molecular weight and cationicity rate.

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Reaction with ferrihydrite surfaces leads to fractionation and stabilization of soil organic matter

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Ferrihydrite, a poorly crystalline Fe oxyhydroxide, is known to be highly reactive towards soil organic matter (OM) and may play an important role in its long-term stabilization. In soil, ferrihydrite formation takes place in the presence of dissolved OM. This disturbs crystal growth and gives rise to coprecipitation of ferrihydrite and OM. To investigate the consequences of coprecipitation, we prepared a series of ferrihydrite-organic matter associations by adsorption as well as coprecipitation using the water-extractable OM of a Podzol forest-floor layer. The reaction products were studied by ¹³C CPMAS NMR, FTIR, and analysis of hydrolyzable neutral polysaccharides. Liquid incubation experiments were carried out to quantify the biodegradation of the ferrihydrite-associated OM (pH 5, 68 days, inoculum extracted from the forest-floor layer).

Relative to the original forest-floor extract, the ferrihydrite-associated OM was enriched in polysaccharides but depleted in aliphatic C and carbonyl C, especially when adsorption took place. Moreover, mannose and glucose were bound preferentially to ferrihydrite, while fucose, arabinose, xylose and galactose accumulated in the supernatant. This fractionation of sugar monomers was more pronounced during coprecipitation and led to an enhanced ratio of (galactose + mannose)/(arabinose + xylose). Incubation experiments showed that 7% of the original forest-floor extract was mineralized after 68 days, whereas a C mineralization of ferrihydrite-associated OM (adsorbed or coprecipitated) was not detectable during the first 13 days. In the following days, a slight increase was observed, but assumed to be caused by processes such as excretion, cell lysis and enzymatic hydrolysis.

The fact that the composition of coprecipitated OM differs from surface-adsorbed OM is of particular interest for our understanding of stabilization mechanisms and turnover rates of carbohydrates. Since the attachment of OM to Fe-oxide surfaces strongly reduces its biodegradation, our findings may explain why labile polysaccharides contribute significantly to the refractory C pool and why the mineral-associated soil OM often shows a high GM/AX ratio.

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Geogenic CO₂ affects mineral and organic soil constituents on a mofette site

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Geogenic CO₂ on mofette sites may be an important soil-forming factor. We studied soils (10-60 cm depth) along a transect across a mofette in the NW Czech Republic by determining soil CO₂ partial pressures (p(CO₂)), contents of C, N, S, and dithionite- and oxalate-extractable Fe and Mn. X-ray diffractometry (XRD) and Fourier-transform infrared (FTIR) spectroscopy were applied to the soils' particle-size fractions. Spatially resolved Fe mineralogy was determined by X-ray absorption near-edge spectroscopy. The CO₂ partial pressures largely varied along the transect (0.001-1) and were positively correlated with both the Corg content (5.5-432.9 g kg⁻¹) and the C:N ratio (9-32). When the soil atmosphere was entirely composed of CO₂, contents of pedogenic Fe oxides were low (minimum 0.5 g Fed kg⁻¹) and poorly crystalline (Feo:Fed up to 0.98). XRD and FTIR spectroscopy revealed primary and secondary minerals such as quartz, feldspars, mica, illite, kaolinite and halloysite irrespective of CO₂. A pronounced effect of CO₂ was found for soil organic matter (SOM), because the FTIR spectra did not reveal the usual accumulation of alkyl C and microbial lipids in clay fractions. This indicates hindered microbial synthesis and/or hindered degradation of plant-derived aliphatic species. In comparison to the clay-plus-silt fractions, we neither detected more organo-mineral associations nor polypeptides in clay fractions at high p(CO₂) pointing to relatively unaltered particulate OM. At high p(CO₂), the FTIR band indicative of lignin became detectable and that indicative of aryl ketones in lignin was positively correlated with p(CO₂). Thus, microbial formation of SOM and organo-mineral associations together with degradation of lignin is decreased under a CO₂ atmosphere.

Iron-K edge XANES data showed that ferrihydrite forms on the surfaces of macropores only, e.g., former root channels. In contrast, the bulk soil matrix was depleted in Fe. There, the primary Fe form was Fe(II) in clay minerals with minor amounts of further Fe(II) minerals such as green rust, vivianite and siderite. At lower p(CO₂), Fe(III) was partially complexed with carboxyl groups. At high p(CO₂), less Fe associated with SOM was detected than at low high p(CO₂), which coincides with the FTIR results.

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Abstracts

**Poster Presentations
by session**

Session 1

Dynamics and stocks of C and N in soil

Interannual variation of SOC fractions in volcanic soils (Canary Islands, Spain)

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Volcanic ash soils, particularly Andosols, are characterised by high organic carbon content due to the stabilisation of soil organic matter in organo-metallic complexes, their association with short-range ordered, allophane-like minerals, and physical protection from microbial attack inside soil macroaggregates and microaggregates. Although C sequestration in Andosols is highly efficient, it is vulnerable both to erosion and aggregate breakdown, which might induce accelerated mineralisation of soil organic C. In this study, we investigated the dynamics of different organic C fractions in volcanic soils of natural ecosystems of the Canary Islands (Spain) to evaluate the stability of their carbon pools and their potential to act as a sink or source of atmospheric CO₂.

The study was carried out in ten experimental plots located in representative Canary Island ecosystems, including both nearly mature and human disturbed ecosystems, over two annual periods. C inputs to (litterfall) and outputs from (respiration) the soil, root C stocks (0-30 cm), soil organic C fractions belonging to C pools with different degrees of biogeochemical stability (total oxidisable C, microbial biomass C, water soluble C, hot-water extractable C, humic C) and total soil N (at 0-15 cm and 15-30 cm) were measured seasonally.

A statistically significant interannual decrease in the C and N stocks and an increase in CO₂ emissions were observed, while the root C stocks and litterfall inputs remained relatively constant. Soil C decreased, mainly at the expense of the most labile C forms (microbial biomass, water-soluble and hot-water extractable) and, to a lesser extent, of humic C. The soils of nearly mature ecosystems were more apparently affected by carbon losses, while those undergoing the process of active natural regeneration exhibited disguised C loss because of the C sequestration trend that is characteristic of progressive ecological succession. The results obtained suggest that the studied soils mainly acted as sources of CO₂ during the study period. The C losses undergone by the studied soils are severe, particularly when we consider the short time of the study. Of course, the variation observed in our results cannot be extrapolated to longer time periods, and only further research will allow confirmation of whether it represents a medium- and long-term trend.

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Total soil carbon stocks in Burkina Faso: survey and behavior

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The over world soil carbon stocks (C) in different ecosystems denote the soil importance as a storage compartment. Nevertheless, estimations at regional levels are scarce. The soil carbon stocks are a resource in the Global Change debate. The soils, in particular in those regions submitted to climatic stress, have a peculiar interest as they could provide information on the impacts of land change use on the climatic changes. The objective of the work is to provide a first global statement of the organic C contents in the soils of Burkina Faso. One particularity of this country is a typical latitudinal climate variation from the sahelian region, open bush vegetation, to the soudanian region, savannah and forest region. A second characteristic is that soils are representative of the all region from Senegal to Soudan. A soil database, Valsol, was performed with information provided by the Orstom's soil survey data, 274,000 km², obtained for the 1:500,000 scale soil map, during the 1970-1975 period. The georeferenced database contains a semantic module organised by soil environment, descriptions and physico-chemical soil profile analysis, this module is associated to a geographical database containing the soil map layers. Based on the 183 soil profiles of reference containing all of them C determinations, the soils' stocks were calculated over their all thickness. The bulk density of soils layers was used. The total soils' stocks contains an organic carbon mass estimated in 1.06x10⁹ CT in the 0-1 m layer, 55 % of the stock is in the 0-0.50 m layer.

A 70 % of the 0-1.5 m stocks concerns raw mineral soils over ferruginous crusts and regic soils over gravelly material and Concretionary leached gray ferruginous soils, ie ferric Luvisols (sols peu évolués gravillonnaires and sols ferrugineux lessivés). The soil profile stocks' distribution were similar within soils' units, 0.025 Ckg⁻¹ m⁻² cm⁻¹. The stocks depends on nature's lithology that, in some situations, is favourable to vegetation inducing great stocks; the mineralogical nature of clays, smectites, is also responsible for some C accumulations. In general Luvisols present C stocks relatively greater than others soils, this in part explained by the thickness of the soil C profile on the kaolinite mantle. Two C distribution in toposequences illustrates the relationships to lithology, soils and vegetation.

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Biodegradation of low molecular weight organic acids in rhizosphere soils under tropical montane rain forest

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Root exudation of organic acids could be an important strategy of plants for acquisition of phosphorus (P) from P-deficient soils under tropical rain forest. However, the efficacy of organic acids on P mobilization in rhizosphere might be reduced by rapid biodegradation by rhizosphere microorganisms. To assess the dynamics and functions of organic acids in rhizosphere, the concentrations of oxalate and citrate in soil solution and the mineralization kinetics of ¹⁴C-radiolabelled citrate and oxalate were studied in the rhizosphere and bulk fractions of soils. We compared two tropical montane rain forests (Mt. Kinabalu, Borneo) that share similar parent materials (sedimentary rocks) and climates but differed in terms of soil age. The older soil (Tertiary age materials) was affected by podzolization and had less inorganic labile P compared to the younger soil (Quaternary colluvial deposits). In the P-deficient older soil, the rhizosphere soil solution contains the markedly higher concentrations of citrate and oxalate than in the bulk soil, whereas the levels of organic acids in the rhizosphere were similar to the bulk fraction in the P-rich younger soil. The rhizosphere effect in P-deficient soils is caused by the greater root exudation and lower adsorption capacities of organic acids. The results of mineralization kinetics show that citrate and oxalate in soil solutions are rapidly mineralized in the rhizosphere and bulk fractions of both P-rich and P-deficient soils, having short mean residence time (0.8 to 1.7 h for citrate and 2.3 to 13.1 h for oxalate). The mineralization rates of citrate and oxalate were highest in the rhizosphere fraction of the P-deficient soil due to the largest pool of organic acids and its replenishment by root exudation. Our data indicate that consumption as well as production of organic acids in rhizosphere could be enhanced in the P-deficient soil. The rhizosphere effects on organic acids under tropical montane rain forest appeared to vary depending on the levels of soil P availability and anion adsorption capacities attributable to soil aging with podzolization.

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Modifications of some soil organic matter fractions in surface horizons of maize soils afforested with different tree species

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Transformation of agricultural soils to afforested soils is considered by the IPCC as an aid to mitigating climate change. This is because the increased plant production involved in afforestation is accompanied by an increase in fixation of atmospheric CO₂. There is also an increase in the input of plant remains to the soils, which generates an increase in the amount of organic matter in the soils. Taking into account the potential mitigating effect on climate change, large areas of agricultural land (often good quality deep soils such as Fluvisols) have been afforested with different tree species. However, little is known about the accumulation of organic matter or about the possible changes in the quality of the soil organic matter as a result of afforestation. In the present study, the quantitative and qualitative changes in some forms of soil organic matter in the surface horizon (0-10 cm) were investigated in relation to afforestation of Galician agricultural soils with different tree species. For this, 38 soils afforested with either deciduous species (29 sites mainly afforested with *Populus alba* L. or *Quercus rubra* L. trees) or evergreen species (9 sites afforested with coniferous trees: *Pinus radiata* D Don or *Cupressus* spp.) were compared with the corresponding agricultural soils situated beside each afforested soil (control soil). The forms of C studied were characterized by acid hydrolysis, determining the total organic carbon, carbohydrate-C and polyphenol-C in each of the two fractions extracted.

The results indicate that in the two fractions obtained the contents of carbohydrate-C, polyphenol-C and total organic C in the afforested soils were generally higher than in the cropped soils from which they originated, although the increases were not significant in any of the cases.

As regards the effects of the plant species used in the afforestation in the above-indicated changes, in all soils planted with deciduous trees there was an increase in the total organic C, carbohydrate-C and polyphenol-C in the two fractions analyzed. In contrast, the results obtained for the sites afforested with evergreen species were very variable. In general, the total C content of both fractions and the content of carbohydrate-C in the most labile fraction were not modified, whereas the carbohydrate-C content of the least labile fraction and the polyphenol-C content in both fractions increased slightly, although the differences were not significant in any case.

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The influence of genetic peculiarities of soils on organic carbon content in the Amur river waters, middle and lower Priamurye, Russia

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The Amur middle and lower reach watercourse is mainly formed in vast mountain areas of Priamurye under excessively humid (wetness coefficient values of 1.2-3.5) continental monsoon climate. The regional peculiarities of soils are attributable to two soil climate facies,

In the continental part (north of 49 degree) the mountain taiga ferrous humus-illuvial soils are formed. The striking peculiarity of these soils is extremely retarded humification of forest litters and accumulation of raw humus in the upper part of the soil profile, where organic carbon (OC) content may reach 17-20%. The CHA/CFA ratio is less than 1, sharply decreasing to 0.2-0.3 in the middle and lower parts of the profile. Strongly acid medium and low altered base content are characteristic of soils along the profile. Our investigations show that a significant amount of total organic carbon (TOC) reaching 18.5 mgC/l is present in the waters of the rivers draining areas of the mountain taiga zone. These are highly colored waters with a high amount of humic and fulvic acids (HFA) attaining 55 to higher percentage of TOC. The FA content is higher than that of HA by the order of 10-12.

Under milder thermal regime in the area north of 49 degree brown forest soils are distributed in the mountains beneath cedar-broad-leaved forests and on the plains beneath herb oak-black-birch forests. The medium reaction is weakly-acid or close to the neutral one; it is noted altered base accumulation in the forest litters and humic-accumulation horizons. The OC content reaches 9-12%. Humus becomes weakly fulvic or even humic in character. Migration of mobile humus fractions is constrained due to their fixation by altered bases rather than by silicate iron compounds. The tendency for the rivers draining the area of brown soil formation to contain less TOC amount (1.5-11.0 mgC/l) is observed. The HFA amount does not exceed 25-30% of TOC.

The Songhua River waters (North East China) are strongly anthropogenically impacted. The high TOC content (to 15 mgC/l) is constantly detected in these, but the HFA content is low (10-15% of TOC). The portion of the organic matter component resulting from anthropogenic impact is large (benzene, its derivatives, etc.). The TOC amount (7-15 mgC/l) in the Amur waters varies greatly along the river and hydrologic sections affected by its major tributaries, the HFA amount reaching 45-50% of TOC.

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Carbon mineralization potential and priming in volcanic soil of pristine temperate old-growth rain forests in Southern Chile

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The studies of carbon (C) stabilization and destabilization in different soil depths are still scarce. To the best of our knowledge no study was carried out investigating those processes in Andisols despite the fact that the carbon storage potential of Andisols is higher than in any other soil type. Stable carbon occurs in this soil type due to its association with Aluminum and Iron oxides and amorphous clay minerals. The aim of this study was to evaluate the potential C mineralization of two Andisols under pristine temperate rainforests and to investigate the possibility of priming using ¹³C labeled cellulose addition. We hypothesized that disturbance of soil structure would have little effect on C mineralization potential of SOC. The study area is located in the Andean mountain range more specifically in San Pablo de Tregüa (SPT), Panguipulli and Puyehue National Park (PNP), Antillanca. Soil samples were collected at three different depths (0-20, 20-60 and 60-80 cm) and were incubated at 20°C with and without addition of cellulose for 80 days. The results showed that C mineralization occurred in all soil horizons from both sites. It was much higher in surface soil compared to the subsoil. The addition of substrate to incubated soils stimulated significantly microbial respiration in all soil depths. However, the addition of cellulose to the subsoil samples did not stimulate C mineralization to the same extent as in the topsoil. The interpretation of the results suggests a lower potential for C destabilization in the subsoil compared to the surface. Therefore, we suggest that the subsoil of Andisols may be regarded as C sinks, due to the strong protection of SOC by soil minerals.

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Salinity decreases dissolved organic carbon in the rhizosphere and increases trace elements phytoaccumulation

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Soil degradation processes, like organic matter (OM) depletion, accompanied with metal contamination and salinisation are getting exacerbated, becoming a serious threat to crop production and human food security. A greenhouse study was conducted to assess a factorial combination of salinity (0, 20, 40 and 60 mM NaCl) and cadmium (0.3, 2.5 and 5.4 mg Cd kg⁻¹) in organic soil (>90% OM) influencing dissolved organic carbon (DOC) in the rhizosphere and mineral phytoaccumulation in radish (*Raphanus sativus* L. var. *sativus*). A 34-day exposure to increasing NaCl salinity significantly decreased DOC concentration in the radish rhizosphere solution and positively influenced on trace elements (Cu, Zn and Cd) concentration, either in the rhizosphere or in leaf/fruit tissues of radish. Soil contamination by Cd progressively raised Cd concentration in soil solution, but markedly reduced total concentration of Cu and Zn, either in the rhizosphere or in radish leaves. The NICA-Donnan chemical speciation/distribution modelling confirmed the predominance of dissolved organic reactive surfaces (i.e. fulvic acid) in Cu and Cd chemisorption/complexation processes in the whole range of applied treatments (NaCl and Cd), whereas for Zn speciation organically-complexed pool dominated at low salinity (0-20 mM NaCl), and free Zn²⁺ was the most important one at increased salinity (≥40 mM NaCl). These results confirm that as a consequence of diminished dissolved organic pool under excessive salinity, Cu, Zn and Cd biogeochemistry in the rhizosphere can be affected in a way that would enhance solubility and phytoaccumulation of these trace metals into the food crops.

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Soil N mineralization and microbial biomass carbon as affected by deforestation induced rise in soil temperature in the hot humid tropics

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Deforestation is known to alter carbon (C) and nitrogen (N) cycles; it is, hence, linked directly with climate change. The present study reports impact of deforestation induced changes in soil temperature and its influence on net soil N mineralization rate, pools of mineral N (NH₄⁺ and NO₃⁻) and microbial biomass carbon (MB-C) in the hot humid tropical climate (mean monthly temperature 28 to 32 °C, rainfall 3000 mm yr⁻¹, RH 71 to 85%) of the South Andaman Islands of India. Treatments included: land uses 4 (moist evergreen forests and derived agricultural land uses i.e. home garden, silvopasture, and grassland) and months 12 representing three seasons (wet: 300 – 500 mm rain month⁻¹, post-wet: 100 – 200 mm month⁻¹, dry: <100 mm month⁻¹). The study also explored loss of soil organic carbon (SOC), and runoff loss of N due to the temperature induced mineralization of organic N. Results revealed that deforestation of the moist evergreen forests reduced tree cover (52 to 100 %), and C and N inputs (23 – 86% and 23 – 83 %, respectively) through litters to the soils and increased soil temperature (0.4 to 9.8 °C across the seasons). The reduction of the canopy cover and inputs of C and N were the lowest in home garden and the highest in grassland, but increase in soil temperature was the highest in grassland and the lowest in home garden. Net soil N mineralization as well as net nitrification rates increased with the rise in the soil temperature, being the highest (55 – 67 %) in grassland and lowest (36 – 44%) in home garden. Conversely, pools of mineral N and MB-C declined with increase in the soil temperature. However, the decline was the highest in grassland and the lowest in home garden. Amount of N mineralized, ranging from 382 to 595 kg ha⁻¹ yr⁻¹, was the lowest in the forest and highest in grassland. SOC loss associated with the net soil N mineralization was 1430 kg ha⁻¹ yr⁻¹ from the grassland and the lowest 127 kg ha⁻¹ yr⁻¹ from home garden. Likewise runoff loss of NO₃⁻ was the highest (13.4 kg ha⁻¹ yr⁻¹) from grassland and the lowest (6 kg ha⁻¹ yr⁻¹) from home gardens. These observations indicate that rise in soil temperature will increase soil N mineralization, which will lead to C and N losses and thereby disrupt carbon and nitrogen cycles.

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Carbon sequestration in organic matter fractions of different ecosystems

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Carbon sequestration in soil is an important strategy to mitigate the increase of CO₂ concentrations, since it involves the transfer of atmospheric CO₂ in more stable soil organic carbon (SOC) fractions. The permanence of SOC depends largely on the balance between contributions and the losses by decomposition, however there are factors that play a fundamental role in stabilizing of soil organic matter (SOM) such as mineralogy, climatic conditions and plowing. One of the most important stabilization mechanisms is the interaction of SOM with soil minerals. But it should be bear in mind that there are other fractions of SOM such as particulate organic matter (POM) and protected organic matter in soil aggregates that may become important at time when a carbon balance should be made. The aim of this study was to determine the stabilization capacity and different sizes of organic compartments in allophanic soils. Include natural prairie, artificial pasture and pristine rainforest in southern of Chile. We used the methods of extraction with sodium pyrophosphate (Alp and Fep) and organic carbon determination with potassium dichromate (Cp). Complementary be performed a physical fractionation with sodium polytungstate to separate the fractions of SOM (fPOM = free particulate organic matter, oPOM = occluded particulate organic matter and MF = mineral fraction) according to John et al. (2005). The results show that SOC variations were explained largely by the Alp and Fep in three ecosystems, additionally determined the natural prairie and artificial pasture have not reached the maximum limit of accumulation of carbon as Cp. On the other hand, the physical fractionation show that a large amount of carbon is present in (oPOM), physically protected from microorganisms. In conclusion, the results indicate that a large amount of organic matter was found to form stable complexes with Al and Fe and to a lesser extent physically protected in oPOM.

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Contrasting soil structures in long term bare fallow treatments and its relation to C storage in soil: is organic matter physically protected in the long term?

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Several mechanisms are thought to explain carbon stabilisation in soils in the long term: (i) physical protection, (ii) protection through interaction with the soil matrix and (iii) chemical recalcitrance. However, disentangling the different stabilization processes is especially difficult. The long term bare fallow of Versailles (42 plots) offer a double opportunity: (i) after 80 years of bare fallow most of total organic carbon is stable carbon kinetically; and (ii) the bare fallow plots have been amended annually with different treatments leading to very contracted soil structure, at least visually. Hence this experiment should allow to analyse the impact of soil structure on the amount and quality of stable organic matter. The selected treatments of the Versailles long-term bare-fallow experiment were those receiving CaCO₃ or KCl, and the control plots, sampled at 2008. Soil macroaggregation was studied by wet sieving, and microaggregation by determining the amount of clay dispersed after soil shaking in water. The aggregate size distribution of the soils after wet sieving was very similar for the three treatments, with less than 10% of stable aggregates bigger than 500 µm. The amount of the fraction under 50 µm increased in the sequence: carbonate plots (13%) < control plots (19%) < KCl plots (29%). Also, the mean diameter values (MWD) were significantly higher for the carbonate plots (0.20 mm), than for the control plots (0.14 mm) and the KCl plots (0.11 mm). When microaggregation was studied, similar results were found, with the sequence carbonate (1,5%) < control (1,8%) < KCl (2,5%) for increasing water-dispersible clay. Small differences were found in the C stocks between treatments, indicating that the better structure in the carbonate plots did not provide for much protection against organic matter mineralization in the long term. These results suggest that macroaggregation can be improved to a certain extent without the intervention of organic matter, by changing the chemical conditions of the soil, which can act upon the process of microaggregate assembling to produce macroaggregates.

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Land use-related modification of labile carbon fractions in soils from Galicia (NW Spain)

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Soil management is one of the key factors in organic matter stabilization in soil, as it influences the amount of carbon and its distribution among aggregate fractions. Here, a series of soils was studied with the objective of evaluating the effect of land use on the labile organic matter pool. The soil series, located in the Pedroso Hill at Santiago de Compostela (NW Spain), included three coarse-textured soils developed over granite, with three different uses: pine-acacia forest (PF), grassland (PG), and maize cultivation (PC). Three different extractions were performed in order to study the labile organic matter: cold water-extractable C, hot water-extractable C, and 0.02N KMnO₄-extractable C. The highest extractive strength among the extracting agents was that of hot water. Cold water extracted more carbon than did permanganate in the grassland soil (PG), and the inverse happened for the forest soil (PF), whereas similar results for the two extractions were obtained in the maize crop soil (PC). The cold water extract was in general unable to discriminate between different uses within each series, whereas the hot water extract discriminated well among uses, showing the following sequence of extracted C: forest > grassland > maize. In turn, the extraction with permanganate was only able to distinguish between the forest soil and the other two. It can be therefore concluded that the size of the labile organic matter pool decreased following the sequence forest > grassland > cultivation, and that hot water was a suitable extractant to establish such differences. The spectroscopic characteristics of the organic matter extracted were also studied, using the UV-VIS spectra of the cold and hot water extracts. The following absorbance ratios, indicating the degree of humification, were calculated: $Q2/6=A280/A660$, $Q4/6=A460/A660$, and $Q2/4=A280/A460$. In cold water, no differences were found for the humification ratios among uses. On the contrary, the ratios in hot water extracts showed clear differences among land uses, with the $Q2/6$ and $Q4/6$ ratios increasing in the sequence: forest < grassland < cultivation, which accounts for a decreasing sequence of aromatic condensation of the extractable organic matter.

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Carbon stocks and carbon management index in physical fractions of a highland Oxisol as affected by pasture management systems

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Soil management systems may affect the soil organic matter (SOM) dynamics, mainly regarding its stock and lability. This study evaluated the distribution of SOM and the carbon management index (CMI) in physical compartments of a surface soil layer (0-5 cm) collected from an Oxisol under different environments: native pasture without burning in the last 41 years, native pasture without burning in the last 8 years and native pasture in soil amended by liming and fertilization and without burning in the last 41 years. Physical fractionation was performed by the densimetric method (sodium polytungstate solution $\rho = 2.0 \text{ g cm}^{-3}$) resulting in a free light fraction (FLF), an occluded light fraction (OLF) and a heavy fraction (HF). Stocks of C in the whole soil and in the physical fractions were determined and CMI was calculated as follows: $\text{CMI} = \text{CPI} \times \text{LI} \times 100$, where: CPI (carbon pool index) = C stock in the treatment/ C stock in the reference; LI (lability index) = C lability in the treatment/ C lability in the reference. Lability is defined as the ratio: labile C/non-labile C; where labile C is the C stock in light fractions and non-labile C is the C stock in the heavy fraction. Native pasture without burning in the last 41 years (CMI = 100%) was taken as reference. Ameliorated soil presented the largest C stocks in the light fractions comprising 13% (FLF) and 18% (OLF) of the soil C. This result is related to the higher forage production in this environment in comparison to the non-managed pastures. The C stock of the HF accounted for more than 53% of the soil C and no difference was found between the environments. This result confirms that this fraction is less sensitive to changes in the soil management system. C stocks of the soil and of physical fractions in ameliorated soil were larger than in the reference environment, and therefore, CPI was higher than 100 %. The LI, due to the high proportion of light fractions, was also higher than 100 in this environment. As a consequence of the high CPI and LI values, the calculated CMI was the highest (197%) in this environment. This result evidences that pasture management based on soil amelioration is an adequate strategy to improve soil quality and promote a sustainable pasture system in subtropical regions. On the contrary, the lower CMI (78%) in native pasture more recently burned indicates adverse impact of ceasing fire without further amelioration of the soil.

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Storage of organic matter in silt-sized and clay-sized fractions of soils as influenced by compost application

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The objective of the present study was to assess the effect of silt-sized and clay-sized fractions on the storage of organic matter (including humus, organic N and sugar components) in the soils received long-term compost application. Soil samples were collected from three plots of different types of management: (a) F, only chemical fertilizers were applied; (b) F+LC, both chemical fertilizers and a low level of compost (5 Mg ha⁻¹) were applied; (c) F+HC, both chemical fertilizers and a high level of compost (15 Mg ha⁻¹) were applied. Silt-sized aggregate (SIA) and clay-sized aggregate (CLA) fractions were recovered by sedimentation after separating sand-sized aggregate fractions by wet-sieving.

A major proportion of total humus (TH), humic acid (HA) or fulvic acid (FA) (52.2-77.5%) was concentrated in the SIA and CLA fractions of all three plots. Their amounts in the SIA and CLA fractions increased with increasing amount of compost applied. The amounts of TH, HA and FA in the SIA fraction were larger than those in the CLA fraction for the F+HC and F+LC plots. The reverse was true for the F plot. The degrees of humification of HAs in the SIA and CLA fractions decreased remarkably in the F+HC plot.

More than 50% of total N (TN) was found in the SIA and CLA fractions of all the plots. Similar results were obtained for most forms of organic N. The amounts of organic N forms were generally higher in the F+LC and F+HC plots than in the F plot. Although the percentage distribution of organic N forms was reduced by compost application, both their amounts and distribution values in the CLA fraction were larger than those in the SIA fraction.

In the quantitative determination of sugar components, 56.6-68.8% of hexose, pentose or uronic acid was recovered in the SIA and CLA fractions. Their amounts were in the order of F < F+LC < F+HC plots. In the CLA fractions, the percentage distribution of all sugar components declined when compost was applied. Such a relationship was not found in the SIA fraction. Both amounts and percentage distribution of hexose and pentose were lower in the CLA fraction than in the SIA fraction. The reverse was true for uronic acid. The findings obtained in this study indicate that the SIA and CLA fractions merit close attention as important reservoirs of soil organic components.

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Modifications to soil C stock in a maize soil afforested with *Populus alba* L.

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The IPCC (2000) recommends afforestation of land to favour fixation of atmospheric CO₂ and thus mitigate climate change. Following these recommendations, much cropland has been afforested in Galicia (NW Spain) since 1992. However, although the IPCC recommendation referred to marginal land, much good quality agricultural land has been afforested in Galicia. Furthermore, although the afforestation took place several years ago, the effects on soil carbon pools have not yet been evaluated in Galicia, and the actual effect of afforestation on the edaphic C cycle is not known.

In this study, the organic matter stocks in soil were investigated, to a depth of 100 cm, in two plots, one afforested 8 years ago with *Populus alba* L. and another plot cropped with maize, which corresponds to the land use prior to the afforestation. Soil samples were collected every 10 cm in both plots, to a depth of 100 cm, and the density was measured in all cases. In all samples the total C and the different forms of C were measured by acid hydrolysis and the total organic carbon, carbohydrate-C and polyphenol-C were measured in each of the two fractions extracted (Rovira and Vallejo, 2002).

The results show that the afforestation has led to a loss of 20% of the C stock in the upper 100 cm of the afforested soil; the loss has affected all forms of C except the total organic C of the most labile fraction in the deepest layers of soil. The total C fraction of the most labile fraction decreased in the first 40 cm of the forest soil in a similar way to the other forms of C determined, whereas in the deeper layers, it increased by approximately 30%. The loss of organic matter due to afforestation may be related to the lack of addition of organic fertilizers to forest soils since the change in land use, whereas the increase in the depth of the most labile C fraction may be explained by the release of exudates from the deepest roots of the trees planted.

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Interrelation between CO₂ and CH₄ production with biological activity and soil properties

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CO₂ and CH₄ production were studied in two sites representative of residual wetlands, with the aim of disentangling flux variability of both gases during one year and their relations with biological activity and soil properties. Sites were situated in the former Lago de Texcoco located between 19° 24' N y 98° 41' W, in a subhumid temperate climate Cw0(w)(I')g, with 551 mm mean annual precipitation and 15°C of annual average temperature. The vegetation of the selected sites was grassland and a forest plantation of eucalyptus and casuarinas respectively, which correspond to the dominant land use of the area. Soils, have alluvial lacustrine origin, alkaline, (pH between 8 to 10.6), fine textured (clay loam to clay) and organic carbon contents (39 to 7.8 g.kg⁻¹). Chambers for the measurement in situ of CO₂ and CH₄ production in soil, soil-roots, and soil- roots- vegetation were established, data were taken in headspace vials every 15 days from September 2008 to January 2010, and measured in a gas chromatograph Agilent 6890. Biomass samples from soil and vegetation were taken and measured. Cores of fresh soil were sampled by duplicate to measure the production in controlled moisture and temperature and other to measure biological activity as alkaline and acid phosphatase, dehydrogenase and protease enzymatic activity. Carbon dioxide showed the greater emissions in the wet and warm seasons in both sites, while methane showed them in the cold season (393 and 2.35 mg×m²×h⁻¹ grassland and plantation sites, respectively). On the other hand, it is evident the greater emission in the forest and its correlation with biological activity for the alkaline and acid phosphatase, dehydrogenase and protease. In enzymatic activity the highest correlations were found at increasing incubation time, however showed a significant high relation for acid phosphatase with production of CO₂ (r²=-0.66). The maximum correlations founded between the CO₂ and CH₄ emissions and the environmental conditions were between CO₂ and environmental temperature (r²=0.54). The emission profile during 24h presented a strong and positive correlation between soil and environmental temperatures and CO₂ emissions (r²=0.93 y 0.9, respectively). In conclusion, the production of CO₂ and CH₄ despite of the complexity of their interrelationships might be associated in a more important way with environmental conditions and acid phosphatase.

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SOC pools dynamics and stability in the 80 years bare fallow chronosequence at Versailles. Evidence of mineral-associated SOC stabilization

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Rates of soil organic matter decomposition, soil organic carbon (SOC) stabilizing processes and their relative strength are still poorly understood. Bare fallows in long-term agronomic experiments, provide unique opportunities to understand SOC decay and stabilization, as changes in amount and quality of the initial SOC can be followed with no contribution of fresh organic matter inputs. To understand the importance of SOC stabilization mechanisms we faced questions: (i) what are the rates of depletion for separable SOC fractions? (ii) What is the final stable SOC pool comprised of?

We studied the chronosequence of samples from a long-term experiment of bare fallow in Versailles, France. Soil samples, taken from the 0-20 cm depth in 1929, 1939, 1949, 1962, 1972, 1991, 2008 and archived since then, contained increasing proportions of stable SOC. Fractionation carried out on 3 independent field replicates was used to obtain SOC pools in clay (<2 μm), silt (2-50 μm), fine sand (50-200 μm) and coarse sand (>200 μm). Silt-size fraction was fractionated into light (LF) and heavy fractions (HF) with SPT solution of 1.8 g/cm³, while fine sand was separated by flotation in water, giving mostly non-decomposed plant debris (POM). Clay and silt heavy fractions are considered as mineral-associated SOC pools, while other fractions as free SOC pools. We measured C, N and δ¹³C concentrations as well as dissolved organic carbon.

The studied soil was polluted by charcoal during the war period in 1940s. To take this into account the decay of SOC pools excluding charcoal was modeled using C/N ratio development in the chronosequence. However, we do not discuss charcoal stability here.

Results show that labile SOC pools in all fractions exponentially declined with time. Turnover rates follow the order: DOM, POM (5-10yr) < LF (15-20 yr) < silt HF (20-30 yr) < clay (30-40 yr). Initially, mineral-associated SOC comprised 57±3% of the total SOC (17.2±0.3 mgC/g soil). After 80 years of SOC depletion clay preserved 39±2% of its initial SOC content, while silt heavy fraction preserved 27±2%. All the free SOC fractions, except charcoal, were depleted completely. Nearly 40% of the stable SOC pool was attributed to charcoal.

To conclude, the major SOC stabilization mechanism in long-term (not considering charcoal) is association with minerals. In particular, clay-size minerals had the strongest ability to stabilize SOC, whereas clay-associated labile SOC pool was the slowest among others.

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Effect of afforestation on soil CO₂ emissions

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The IPCC (IPCC, 2000) declares that afforestation may lead to accumulation of organic carbon in plant biomass and soils, which may contribute to the removal of atmospheric CO₂, the main greenhouse gas. Afforestation has therefore been suggested as a method of carbon sequestration in soils, although few studies have investigated the influence of this practice on soil carbon dynamics and on modifications to carbon stocks, at least in Galicia (NW Spain).

The present study aimed to investigate how the afforestation of agricultural soils (maize cropped soils) affects soil CO₂ emissions throughout the year. For this purpose, we are currently monitoring, by use of a portable Infra Red Gas Analyzer and a soil chamber, three different afforested soils in Galicia (NW Spain): one *Quercus rubra* L. plantation (Balaira) and two *Populus alba* L. plantations (Laraño and Pontevea), as well as three agricultural soils from plots beside each of the plantations and that represent the original soil prior to afforestation. The variations in the soil CO₂ efflux are measured once a month, during an entire day, in each of the six plots, and the values obtained for afforested soils are compared with those obtained for the corresponding agricultural soils. We cannot yet make general conclusions from the results obtained, as although the CO₂ emissions appear to be correlated with soil temperature and air humidity, the behavior of the three soils relative to the respective control (agricultural) soils is very variable, as in some cases more CO₂ is emitted from the afforested soil than from the agricultural soil, the opposite occurs in others and in yet others there are no differences between the soils. At present we are investigating whether the variable patterns are maintained throughout the year and if it is possible to establish the determining factors.

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Influence of silvicultural treatments on the soil properties in burned and unburned Mediterranean forests

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Sustainable forest management needs to consider ecological aspects as for example soil health and quality, which is critical for ensuring the sustainability of the environment and the biosphere. Soil quality depends on a large number of physical, chemical, biological, microbiological and biochemical properties, the last two being the most sensitive since they respond rapidly to changes. In fact, it is widely accepted that a high level of microbial activity is necessary for the maintenance of an adequate quality of soil and vegetal cover which positively influences soil fertility. On this context, the aim of this work is to evaluate the effects that silvicultural treatments have on the microbial activity and biomass of soils in burned and unburned Mediterranean forest areas. Several sensitive parameters related to the microbial activity of the soil such as soil respiration and biomass carbon and some enzyme activities (urease, phosphatase, β -glucosidase and dehydrogenase) were evaluated in two seasons (summer and autumn). Physical and chemical soil parameters (organic matter, total nitrogen, phosphorus, pH, conductivity and carbonates) were also evaluated at each experimental forest area. Results showed that silvicultural treatments, forest fire and season of the year factors have a significant effect (P -value <0.05) on soil biological activity. A significant correlation was also found between microbiological and biochemical parameters and physicochemical parameters, organic matter and total nitrogen. Adaptive management forest plans should consider our results in order to achieve a sustainable forest management, especially on the context of soil quality of burned and unburned Mediterranean forest.

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Does clay mineralogy influence aggregation formation and stability? Insights from fractionation analyses conducted on soils under different land-uses.

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Clay mineralogy influences aggregation processes in soils. However, the role of clay mineralogy on aggregate formation and stability has seldom been properly investigated. Indeed, most studies dedicated to this subject compare highly different soils. This implies that many parameters co-vary with clay mineralogy impeding clear conclusions. To avoid this bias, we compared in this work the mineralogy of clay fractions of different aggregate sizes recovered from the same soil subjected to different land-uses. We hypothesized that (1) the clay size fractions of aggregates is enriched in expandable 2:1 clay minerals compared to free clay fraction; (2) this enrichment is more important for silt-size and micro-aggregates (50-250 μm) than for macro-aggregates (>250 μm) for which aggregation mechanisms may rely mainly on biological agents (fungal hyphae, fine roots); (3) this enrichment depends on soil disturbance induced by agricultural practices.

We tested these hypotheses by separating different aggregate sizes (free clays/free silt/micro-aggregates/Macro-aggregates/Large macro-aggregates), in a protocol based in the hierarchical model of aggregate formation and stabilization. The protocol was applied to a Calcic Silty Soil (Versailles, France) under 3 different land-uses: grassland, no-till and organic farming (tilled every year without organic fertilization). The clay fractions of every aggregate size were recovered and analysed using X-ray diffractometry. The results are discussed.

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Nitrate leaching loss under crop-livestock systems in the Cerrado region, Brazil

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Nitrogen is the most limiting factor in crop production. However, its use efficiency remains low because of the severe losses caused by volatilization and leaching. Nitrate leaching has long been recognized as a serious problem, in both developed or developing countries, leading to the pollution of both surface and groundwater or to the accelerated soil acidification due to leaching of NO₃- associated to basic cations. Conservation Agriculture (CA) practices, such as non-tillage (NT) or integrated crop-livestock management systems (ICLS), are considered as alternatives in the sustainable management of tropical soils in order to minimize these losses. The objectives of this study were therefore (i) to estimate the beneficial effects on N leaching of ICLS systems in comparison with continuous crops or pasture in the Cerrado region, and (ii) to evaluate the impact of tillage (no-tillage versus conventional tillage) on N leaching. A field experiment was conducted at the Embrapa Cerrados Research Farm in the Cerrado region, Brazil. The soil is a Gibbsic Ferralsol. Five treatments, corresponding to various management systems in combination with different tillage regimes, were selected: continuous pasture, continuous crop with conventional tillage, continuous crop with no-tillage, crop/pasture rotation with no-tillage and pasture/crop rotation with no-tillage. Bulk soil samples were collected and 1 M KCl extractable nitrate determined. Soil water samples were collected with ceramic suction cups samplers during two rainy seasons at two depths (20 and 150 cm), at approximately two weeks intervals, and analyzed for NO₃⁻. Water flux through the root zone was estimated using the water-balance module of the numerical model SARRA (Système d'Analyse Régionale des Risques Agroclimatiques). Under continuous crop and conventional tillage, the nitrate anion concentration in soil solution was high at both depths, with concentrations as high as 8.500 µM L⁻¹ at 20 cm and 600 µM L⁻¹ at 150 cm. Cumulative losses of nitrate reached 61 and 33 kg ha⁻¹ for the first and second cropping years, respectively. Under no-tillage, the leaching losses decreased to 20 and 12 kg ha⁻¹ for the first and second cropping years, respectively. Under pasture and ICLS, the losses remained lower than 2 kg ha⁻¹ for each cropping years. Then, ICLS systems appeared as an efficient management system to limit leaching losses and improve N use efficiency.

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Characterizing organo-mineral complexes in surface and subsurface horizons of an acid loamy soil using sequential density fractionation

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Soil scientists have acknowledged for years the ability of the organo-mineral complexes to protect soil organic matter. Recently, KLEBER et al. (2007) conceptualized an interaction model between humic compounds, as defined by SUTTON and SPOSITO (2005), and mineral surfaces. They suggest a self-assembly of organic molecular fragments in three structural zones: (i) a “contact zone”, consisting of proteic compounds adsorbed to the mineral surfaces; (ii) a “zone of hydrophobic interactions” and (iii) a “kinetic zone” in the outer region, mainly through electrostatic bounds.

Our objective was to separate organo-mineral complexes by density fractionation according to their mineralogy after the method of BASILE-DOELSCH et al. (2007) in order to (i) observe their structural organization, (ii) quantify their adsorption capacity and (iii) characterize the organics compounds sorbed on minerals surfaces in relation with Kleber et al 's model.

The soil studied was an acid loamy soil under natural pine forest. Soil samples were taken from surface (0-30 cm; ~50 mgC.g-1) and subsurface (30-50 cm; ~30 mgC.g-1) horizons. Organo-mineral complexes were characterized by SEM imaging and XRD, ¹³C-NMR, $\delta^{13}\text{C}$.

We observed, in both horizons, that organo-mineral complexes formed by aluminosilicates (illite, kaolinite and montmorillonite mainly) are micro-aggregates of about 20 μm , involving many mineral particles smaller than micrometer size. They have a high SOM content, up on ~200 mgC.g-1. However, organo-mineral complexes formed by coarse (~40 μm) primary minerals (quartz, feldspars) are weakly associated with SOM (<10 mgC.g-1) and shows the presence of fine mineral particles aggregated on coarse minerals, probably by an organic interface.

Furthermore, we observed an isotopic enrichment and reduced C/N of SOM sorbed on mineral surfaces, compared to uncomplexed SOM. SOM bounding with aluminosilicates showed an isotopic enrichment about +1.2 ‰ in surface, +0.4 ‰ in subsurface horizon and a C/N depleted about -8.7 in surface and -13.9 in subsurface horizon. SOM bounded to primary minerals are more enriched in ¹³C and nitrogen.

We compared our data with works carried out on different soil mineralogy and fund a significant correlation between the ¹³C enrichment and the reduced C/N of sorbed organic compounds according to their C content. This general trend supports a multilayer adsorption model, assuming protein compounds with a high ¹³C involved in all complexation processes.

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Relative contributions of organic and inorganic carbon in the CO₂ emitted from a Tunisian calcareous agricultural soil: Effect of increasing temperatures

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Terrestrial ecosystems play a major role in regulating atmospheric CO₂ concentrations. The net balance of photosynthesis and autotrophic and heterotrophic respiration corresponds to a current terrestrial sink of about 1 Pg C, but any increase in global respiration may change the global ecosystem from a sink into a source of CO₂. Our study focuses on heterotrophic soil respiration (SR) which represents roughly half of the global respiration.

Despite an important research effort, the temperature dependence of SR, i.e. soil organic carbon (SOC) decomposition is still in debate. Moreover calcareous soils, which cover more than 30% of lands, were poorly studied. One difficulty when studying SOC dynamics in calcareous soils is the presence of inorganic carbon which interferes with organic carbon measurement. Indeed CO₂ emissions derive from the mineralization of organic C and also from the dissolution of inorganic C (CaCO₃). Few approaches attempted to measure the contribution of the carbonates in the CO₂ emitted from calcareous soil, but at our knowledge no studies monitor the effect of increasing temperatures on this contribution. This study was thus designed to quantify the relative contribution of organic and inorganic C to the amount of CO₂ emitted from a calcareous soil with increasing soil temperature.

Calcareous soil samples with a CaCO₃ content of 4.3% were collected from a cultivated plot under cereal culture in a semi-arid region in Northern Tunisia. Soils were incubated for 28 days at four different temperatures (20, 30, 40, 50°C). The δ¹³C signatures of soil, SOC, CaCO₃ and δ¹³C signatures of the CO₂ emissions at 7 and 28 days of incubation were measured.

Our results showed that CO₂ emissions increased with increasing temperatures. The δ¹³C signatures confirmed that the CO₂ emissions derived from both SOC (77±9%) and soil carbonates (23±9%). During the first 7 days of incubation, the contribution of inorganic C to CO₂ emission was slightly higher at 50°C than at 20°C (35±4% vs. 30±2%). This contribution decreased with the length of soil incubation, it was only 15±1.8% after 28 days of incubation whatever the incubation temperature. We calculated a same Q₁₀ index with total CO₂ emissions (1.9±0.5) or with CO₂ derived only from SOC (1.9±0.04). In conclusion, using isotopic ¹³C signatures is not necessary to analyze the temperature sensibility of SR in this calcareous soil.

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The influence of the interaction of treated sewage effluent and compost on the dynamics of the nitrogen in the soil

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Compost contains nitrogen in an organic form which is slowly mineralised whilst nitrogen (N) present in treated sewage effluent is much more available. We wanted to understand the influence of interaction of these N sources on soil N dynamics. Hence, an incubation experiment was carried out to study the influence of the interaction of compost and treated sewage effluent on N dynamics in the soil. Different combinations of greenwaste compost and treated sewage effluent were made on sandy loam and clay loam soils to supply 37.5, 75 and 150 kg total N ha⁻¹. The experimental design was a randomised block design with five treatments and a control (no amendment) replicated three times. The treatments were, compost alone ((75compost + 0effluent) and (150compost + 0effluent)), effluent alone (0compost + 37.5effluent) and compost-effluent integration ((37.5compost + 37.5effluent) and (112.5compost + 37.5effluent)). The soil samples were incubated for 120 days at 25 °C with moisture content maintained at field capacity. N mineralisation (as % of the total N applied) was high ($p < 0.05$) in clay loam soil as compared to sandy loam. In sandy loam soil, treatments with integrated nutrient supply ((37.5compost + 37.5effluent) and (112.5compost + 37.5effluent)) and treatment with effluent N only (0compost + 37.5effluent) showed initial decline in mineral N during the first 30 days after which a gradual increase in mineral N was observed. N dynamics in treatments with nutrient integration in clay loam soil ((37.5compost + 37.5effluent) and (112.5compost + 37.5effluent)) were not significantly different to each other and to the (0compost + 37.5effluent) treatment. When fitted to the one-pool model (first-order kinetics), the potentially mineralisable N in the clay loam soil though not significantly different ($p > 0.05$) amongst the treatments, was high for (0compost + 37.5effluent) treatment followed by the (37.5compost + 37.5effluent) and (112.5compost + 37.5effluent) treatments while the control registered the lowest. Initial conclusions suggest that compost/effluent integration is recommended despite accumulating relatively less mineral N as compared to the treatment with sewage effluent N alone, as less of each nutrient source is applied thereby limiting the excessive nutrient accumulation and improving the availability of N from compost.

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No tillage affects soil organic matter, glomalin and soil properties in an alfisol of central-south Chile

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The use of no-tillage (NT) system increases the soil organic matter (SOM) levels, improving physical, chemical and biological soil properties. However, its beneficial effects on soil are conditioned for the time that the soil is managed under this practice. Another key factor influencing the SOM dynamic in the agroecosystems is the presence and activity of arbuscular mycorrhizal fungi (AMF), which are related to SOM stabilization by means of soil particles aggregation, through the fungal mycelium action and a glycoprotein called glomalin. Such protein is an AMF product extracted from the soil and characterized as glomalin related soil protein (GRSP). This study aimed i) To compare the effect of short and long term under NT on humic substances and GRSP contents; ii) To determine the contribution of GRSP to soil C pool and iii) To relate the GRSP content with organic matter and water stable aggregates. The study was carried out in an Alfisol of Central-South Chile managed during 6 (NT6) and 20 years (NT20) under no-tillage system and crop rotations in which it was included Wheat (*Triticum aestivum*: W), Lupin (*Lupinus albus*: L) and Triticale (*Triticum secale*: T). Soil was sampled at 0-5; 5-10 and 10-15 cm depth. We measured the content of fulvic acids, humic acids and humin, glomalin (GRSP), water stable aggregates (WSA) and water holding capacity (WHC) among others. The results showed a decrease in humic and fulvic acid contents in NT6 treatment, but an increase of humin content with NT20 at all depths evaluated. GRSP decreased in the soil according to more years under NT and soil depth, ranging from 12.9 mg g⁻¹ to 10.4 mg g⁻¹ at NT6 and NT20, representing 13.8 and 13.4% of total soil carbon respectively. The stable aggregate percentage was high under NT6 (44.3%), whereas NT20 reached percentages of 26.6%. Our results evidenced that a long-term period under no-tillage affected the soil organic matter fractions measured. Positive relationships between GRSP fractions and WSA, and GRSP and organic carbon suggest an active role of GRSP on soil aggregation, and the stability of organic matter in the soil of the agroecosystem studied, highlighting the effect of long-term NT system, which could change the distribution of SOM fractions and decrease GRSP contents. Financial Support for this Research was supplied by the National Commission for Scientific and Technological Research (FONDECYT 1100642)

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Trends in soil properties with view to glomalin and structural stability relationship in abandoned terraced soils of NE Iberian Peninsula

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Abandoned areas in NE Spain, have increased soil vulnerability to degradation and erosion, especially when wildfire occurs throughout the dense and disorganized scrubland cover. The fire causes a regressive dynamics in the vegetation and in soil properties affecting organic matter content and structural stability, thus reducing soil resistance to erosion processes. By contrast, areas less affected by fire, may have evolved spontaneously creating favourable conditions for the regeneration of a stable organic horizon. This picture have arisen questions on the need of appropriate management of abandoned land and the recover of the landscape heterogeneity in order to contrast threats of desertification. The area of study is located in the Cap de Creus Peninsula, NE Spain, (Lat 42°20'4"N , Long 3°6'19"E) having a typical Mediterranean climate. Soils are shallow, sandy, with thin organic horizon, low clay content and have Ap, C/R horizon development, been classified as Lithic Xerorthents. Our investigations were based on the monitoring of soil properties and erosion processes in seven soil environments representing a sequence of land use and cover change. Soil under vines, olive groves, cork trees, pine trees, different stage of scrubs, and pasture were selected in order to classify both soil environments at risk of degradation and soil environments showing capability to preserve organic compounds against loss as CO₂. As soil structure is the expression of soil health, its relationships with organic compounds and a recently reported soil component, glomalin, have been studied. Glomalin, is a glycoprotein produced by arbuscular mycorrhizal fungi (AMF), mutualistic symbionts with the roots of the majority of land plants which is able to form and preserve stable aggregates increasing the storage of organic compounds.

Soil properties, measured on monthly basis from autumn 2008 to autumn 2009 showed that water holding capacity, organic carbon and total nitrogen, increased in the sequence of land use and cover change, from soil under vines, olive groves, pine trees, cork trees, burnt scrub, unburnt scrub, and soil under pasture giving a clear indication of the contribution of cover change to soil quality. The ability of glomalin, both total (TG) and easily extractable (EEG) was checked with the aim of understanding its role in aggregation. Water stable aggregates were found to be well correlated with glomalin along the period of study. Moreover, the soils with hi...

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Role of carbonates and clay minerals in macroaggregates dynamics and organic matter stabilization in semi-arid Mediterranean soils

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Soil carbonates contribute to aggregation and organic matter (OM) stabilization in many semi-arid soils. Moreover, interaction between carbonates, OM and clay minerals can change the relationship between aggregation and OM dynamics described in the hierarchical model. However, the relative effects of these aggregation agents on macroaggregation have not been addressed so far in naturally-carbonated soils. This was the aim of this work. To do so, the fraction <250 µm of a carbonate-rich Typic Calcixerept (CR), a non-carbonated Typic Haploxerept (NC), and a non-carbonated clayey Calcic Haploxerept (NCC) from the semi-arid Mediterranean Ebro Valley (Spain) were incubated with/without maize straw during 105 days. The three soils differed on carbonates and clay mineral proportions: NC and CR had a similar proportion of clay-size silicates (~10%), while NCC and CR had a similar proportion of total clay-size particles, including carbonates (~20%). A set of samples was fractionated every 21 days, to isolate macroaggregates (Magg), microaggregates (magg), silt+clay (s+c), and magg within Magg (mMagg) fractions. Macroaggregate turnover and mMagg formation in NC and NCC was dependent of OM incorporation and decay, according to the hierarchical model. However, in NCC Magg dynamics was less dependent on OM very likely due to a greater clay minerals proportion. In CR, straw addition also enhanced Magg formation, but neither decline of Magg amount nor transfer of maize-derived C from Magg to magg was observed. This indicated that Magg had a longer turnover rate in CR. An increasing accumulation of calcite in mMagg and Magg in CR, parallel to a preferential selection of illite could explain these results. Both in CR and NCC, a greater proportion of mMagg was observed, which resulted in greater proportion of OM protected in this fraction compared to NC. Based on these results, we carried out a short-term incubation with CR and NCC, in similar conditions, to study the interaction of carbonates and clay minerals in the early stages of macroaggregate formation. The same fractionation protocol was applied at days 3, 7, 14, 21 and 28. Although Magg dynamics was similar in CR and NCC, differences in their mineralogy indicated that they can have different pathways of aggregates formation and stabilization. The results emphasize the crucial role of calcite for macroaggregation which can help to improve C sequestration in semi-arid agricultural soils under sustainable management.

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Soil structure effect on the biodegradation of native and added organic matter

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Predicting how soil organic carbon stocks will evolve is an important issue in the double context of climate change and the rapid evolution of cropping systems. In order to better understand how soil carbon dynamics will be affected by various changes, it is necessary to identify the regulatory mechanisms of soil organic matter decomposition. The activity of soil microbial communities and their diversity are thought to play a key role in regulating organic carbon dynamics. But recent research has suggested that it is abiotic processes (e.g. “physical protection”: diffusion, local physicochemical conditions) that regulate C dynamics whilst microbial abundance and diversity is unimportant. The aim of this study was to analyse and assess the relative importance of soil structure in the regulation of soil organic matter dynamics. We focused on soil structure because this abiotic factor determines substrate accessibility to microbial decomposers. We used a soil from a long-term experimental site that varies in physical structure and organic matter content (Essai de “La Cage”, Versailles, France).

In order to test the effect of soil structure on decomposition, soils cores with different structures (undisturbed, disaggregated at the 5 mm scale (by sieving) and disaggregated at the 50 µm scale (by agitation in water)) were incubated and the mineralization of organic matter (both native and added) compared. ¹³C-labelled substrates (fructose and vanillin) were used to stimulate the activity of soil microorganisms. During the incubation, the CO₂ released was measured by micro-GC and the CO₂ isotopic signature determined by GC-IRMS. This allowed us to differentiate the CO₂ evolved from the added substrates from that of the native soil organic matter.

In order to relate the respiration kinetics to the different physical structures induced by the treatments, X-ray micro-tomography was used to identify solid and pore space in the samples. This technology enabled us to quantify pore geometries, providing information on porosity, pore connectivity, fractal geometry and pore size distribution.

Soil structure appears not to have any effect on total, soil organic matter and substrate mineralizations, despite the different physical environments observed between our soil structures in X-ray micro-tomography. These results suggest that the controls on carbon dynamics take place at scales below those that were modified in this experiment.

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Effects of soil temperature and moisture regimes on concentrations and their corresponding natural $\delta^{13}\text{C}$ abundance along forest soil profile under two tree contrasting species

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This study investigated the influence by climate change on soil carbon decomposition and sequestration for 2 years (2009~2010). Among climate factors, soil temperature and moisture regimes are the concerned factors. To study the impact of soil temperature, soil was sampled in two site, Baekun Mt. (14.2 °N), South Seoul National University Forest in Kwangneung and Taehwa Mt. (11 °N), Taehwa Seoul National University Forest in Kyonggi. According to the IPCC (Intergovernmental Panel on Climate Change), the precipitation and air temperature on 2100 year could be expected. Incubation which adjusted the condition in IPCC was experimented for 73-days. At this point, litter and 0~10 cm soil deep were sampled under typical conifer tree (*Pinus koraiensis*) and broad leafed tree (*Quercus acutissima*) to evaluate differences of tree species. Soil Carbon contents, total Nitrogen contents, natural $\delta^{13}\text{C}$ abundance and natural $\delta^{15}\text{N}$ abundance were estimated.

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HPLC Analysis of Chromophoric Dissolved Organic Matter in Antarctic Soil Core: Comparison with Microbiology Data

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The antarctic ground and soil samples have so far been insufficiently studied. Resulting that a little is known about dissolved organic matter (DOM) characteristics in antarctic environment. There has been no systematic study of the microbial diversity of antarctic ground active layer and upper permafrost samples as well.

Analytical methods based on HPLC have often been used to characterise aquatic DOM on molecular level. The coupling of HPLC option - high-performance size exclusion chromatography (HPSEC), with diode-array detection (DAD) enables qualitative and semi-quantitative analysis of chromophoric DOM (CDOM).

In the present study we investigated the chromatographic and spectroscopic properties of CDOM extracted from ground active layer and upper permafrost core (1.9 m deep) taken from Schirmacher Oasis, Antarctica on March 2009. The microbial analysis was carried out by plating the melted core samples on two different nutrient-poor agar media for the detection of the number of colony forming heterotrophic bacteria (HB).

The HPSEC-DAD analysis confirmed the absence of absorption maxima at wavelength region 250-350 nm, reflecting to the lack of aromatic and humic compounds in antarctic CDOM. However, peaks were detected by using detection at 210 to 230 nm, thus referring to the presence of aliphatic carboxyl-groups in CDOM. The relative molecular masses were estimated to be below 200. Analysis of HPSEC peak areas (as rough estimation of CDOM quantity) showed increasing down-core concentrations starting from depth 1.3 to 1.9 m.

The microbial analysis resulted to extremely high HB numbers in surface layers (3-19 cm) and the sharp decrease at the depth of 34-62 cm. The growth of HB was detected to the depth of 1.15 m. The HB number was higher at +4°C than at +20° C. The comparison of HPLC and microbial analyses results indicated three regions in antarctic core: (i) 3-19 cm with characteristic high HB number (several hundred thousands) and absence of CDOM; (ii) 0.26-1.15 m with low HB number (1000-2000) and low CDOM concentration; (iii) 1.3-1.9 m with high CDOM content and absence of bacteria. Obtained data were statistically treated by cluster and principal component analyses.

The study demonstrated that combining HPLC and microbial analyses is potentially a promising tool of investigating changes in antarctic soil CDOM.

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Dynamics of clay-fixed ammonium in soil as a source or sink of mineralized nitrogen in paddy ecosystems

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Interlayer of 2:1 clay minerals in soil is a space that enables to fix NH_4^+ . From 3 to 10% of total N is fixed in a wide variety of surface soils. The proportion increases with soil profile depth, and in some subsoils, more than 85% of the total N is fixed NH_4^+ (Young and Aldag 1982). Clay-fixed NH_4^+ , however, does not remain the interlayer spaces, can leave its space depending on the NH_4^+ concentration in soil solution, the extent of NH_4^+ specific adsorption, and the distance from exposed edge.

A sequential determination method was developed that enables to measure exchangeable N by 2M KCl extraction and fixed NH_4^+ by Silva & Bremner method (1966) in the same soil. Using this method, whether fixed NH_4^+ in soil acts as a source or sink of mineralized N in paddy ecosystems was evaluated. Frequent residue input and fluctuating soil moisture content are two main features of paddy ecosystems. In this experiment, therefore, a paddy soil was incubated anaerobically for a total period of 70 days with or without application of powdered rice straw as a pretreatment and with or without air-drying as a posttreatment. On days 0, 7, 28, 49 and 70, soil samples were analyzed by the above sequential method.

A linear relationship was found between the concentration of KCl-extractable NH_4^+ and clay-fixed NH_4^+ for air-dried soil samples. During the incubation, the concentration of KCl-extractable NH_4^+ increased consistently. The concentration of clay-fixed NH_4^+ decreased in the initial 7 days and then increased in accordance with the increase of KCl-extractable NH_4^+ until the end of the incubation. Among the experimental treatments applied, air-drying exhibited the most pronouncing effects on NH_4^+ fixation. The effect of air-drying on NH_4^+ fixation was greatest for soils after 28-day incubation and was decreased thereafter. The effect of air-drying on fixation might be regulated by the fixation capacity of the interlayer space. On the other hand, the effect of rice straw application on the concentration of clay-fixed NH_4^+ was negligible, although its application caused significant decrease of KCl-extractable NH_4^+ due to immobilization. Potassium ion released from the straw might have prevented clay-fixed NH_4^+ from releasing.

These results revealed dynamic interactions of KCl-extractable NH_4^+ and clay-fixed NH_4^+ in paddy soil ecosystems.

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Effects of climate change parameters on the availability of cations in the soil water

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Studies were conducted with Mediterranean forest soils to evaluate the potential influence of precipitation and temperature changes, upon the soil water chemistry. We examined, during a two-years period, the response of soil cores to experimental warming and decreased precipitation regime using laboratory incubations. Ten soil cores were collected from a natural Mediterranean shrubland in the upper basin of the “Barranc del Carraixet” and Alcuablas mountains areas in Valencia (E Spain). Both soils were classified as Rendzic leptosols developed on calcareous material. Cores were divided in two sets and incubated in two climatic chambers under different conditions. During the experimental period, the first chamber simulated ‘normal’ Mediterranean air temperatures and precipitation. In the second chamber air temperature was increased by 3 °C and precipitation decreased in a 10% respect to the first one. We studied the properties of leachates of these ten cores subject to displacement with tap water, in columns, and investigated their relationship with soil properties. When cores were exposed to warmer temperatures and the volume of irrigation inputs decreased, percolates showed increased the availability of cations in the solution phase. These climatic conditions also affect on leachate dissolved organic matter and on soil physical and chemical properties. The elements variations could be explained by the combination of several processes, such as accelerated soil organic matter mineralization and increase leaching losses of cations due to the irrigation events.

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Dynamic of soil structuration by earthworms - Influence of earthworms on soil organic matter composition and bacterial communities

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Earthworms are key actors in soil structure formation through the formation of casts and the incorporation of soil organic matter in the profile (Brown et al., 2000, Scullion et al, 2000). Moreover earthworm casts are known to be enriched in clay and in organic carbon. In consequence they play an important role in organo-mineral interactions. In addition earthworms can affect microorganism communities (Mummey et al., 06) either by modifying their environment or the nutrient accessibility (providing carbohydrates through mucus production or incorporation of fresh organic matter in deeper soil layer). The determination of the phospholipid fatty acid (PLFA) pattern allows the insight of microbial communities. Thus soil microorganism community variation could be revealed by comparison of phospholipid fatty acids profile extracted. However the earthworms contributions differ according to the type of earthworm considered (epigeic, endogeic or anecic).

In consequence, the aims of the study were to compare the effects of two types of earthworms (endogeic vs anecic) i) on soil structure and the dynamic of its formation, ii) on microorganism communities and iii) on organic matter composition considering the total organic carbon and nitrogen but also the molecular composition of the organic matter.

We carried out an experiment to evaluate the effect of the anecic earthworm (*Aporrectodea giardi*) and the endogeic earthworm (*Aporrectodea icterica*) at high density (30 individuals in 5L) on soil structure and soil organic carbon and nitrogen, over a 2.5 months period. We compared these measures between fine soil, casts and in the dissolved organic carbon. In addition molecular composition of the organic matter in these compartments was also determined by pyrolysis coupled to gas chromatography mass spectrometry and PLFA have been characterized from the soil and from casts extracted from the two treatments.

The first results reveal an increase of the proportion of aggregates in the two mesocosms and chemical discrepancies between fine soil and casts. In one hand analyses evidence change in carbon and nitrogen content between fine soil and cast and in the other hand the molecular composition exhibit different distribution of the compound series

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Changes in soil chemical properties with different tillage systems and crop rotations in a semi-arid area of Castille-Leon, Spain

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Tillage systems have a very important influence on soil properties. Minimum (MT) or no tillage (NT) and increased cropping intensity can enhance soil structure and raise carbon sequestration in agricultural soils. Conservation tillage improves soil and ground water quality and benefits soil micro fauna and environment. These changes depend on soil type, climatology, used crops and tillage management systems.

This paper reports the effects of various tillage systems. no-tillage (NT), minimum tillage with chisel plow (MT) and conventional tillage with mouldboard plow (CT), and different crop rotations on pH, soil organic and particulate carbon (SOC and POC), soil organic nitrogen (SON) and macronutrients on the profile distribution (0-60 cm). The study was conducted from 2004 to 2009 at Zamadueñas, Valladolid, in a Spanish cereal farming area, on Typic Xerofluvic soil with a 1.0 % soil organic matter content. A split-plot experimental design was used, in which the main factor was tillage system and sub-factor crop rotations. The objectives were to determine the impact of conventional and conservation tillage on soil chemical properties and to assess and compare several stratification ratios as indicators of soil quality in a semiarid area of Castile-Leon, Northern Spain. The results obtained at the end of five years showed that conservation tillage systems (minimum tillage and no-tillage) have had a positive influence on soil quality. This has been due to a general improvement of soil chemical properties such as soil organic carbon, nitrogen and fertility.

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Influence of rice residues management on the soil and water biogeochemistry

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Two rice-cultivated plots with different residual management practices, one with incorporated residues (I.R. plot), the other with burnt residues (B.R. plot) were studied by in situ monitoring of the soil solution: pH, Eh, temperature and electrical conductivity were registered automatically every 1 hour during several months. Chemical composition was analyzed, some unstable parameters being measured in the field. Time-series were analyzed by Fourier Transform, and geochemical equilibria between soil solutions and solids were checked.

Both plots remained throughout the cultivation period oversaturated with respect to calcite, larger saturation indexes being observed in I.R. plot, where larger alkalinities and calcium concentrations are observed as compared to B.R. plot, while pH is nearly identical. This can be ascribed to the larger partial pressure of carbon dioxide when residuals are incorporated. In I.R. plot, more reducing conditions were observed, ferrous ion being released at low redox potential. Accordingly, ferrous carbonate (siderite) may form as solutions are slightly oversaturated with respect to siderite.

After flooding, the pH decreased then reached a steady value close to 7.1-7.4 in all plots. This value is in the range of pH of a solution in equilibrium with calcite and soil atmosphere CO₂, i.e. between 6.9 and 8.5 depending on temperature and partial pressure of CO₂. The pH departed from this steady value either by alkalization due to urea addition or by acidification due to rhizospheric effect. In both cases, pH then went back to the same steady value. Kinetic laws were fitted to the data following urea addition. Exponential laws were obtained, which allows us to determine relaxation times. Two different kinetics were superimposed: a slow kinetics with a relaxation time of 500 hours for burnt residues against 172 hours for incorporated residues, and a fast kinetics due to daily oscillations with relaxation time more variable from 3.5 to 11 hours. This variation is related to temperature variations. This can be interpreted as follows: during the night, in the absence of root absorption, urea hydrolysis is dominant and result in an increase of pH; during the day, root absorption of ammonia is dominant, with a correlative excretion of protons by rhizosphere, which results in a decrease of pH of soil solution. This study shows the interest of in situ monitoring of soil solution to study soil solution / plant interactions.

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Water infiltration rate an indicator of physical quality recovery of an Oxisol

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The use of natural resources inappropriately usually gives rise to a new ecological system is not sustainable. Thus, soils and intensively used inappropriately, are led to degradation. Different techniques are being used to ameliorate these soils, mainly by the addition of organic matter, but information on the time required for soil recovery, influence of the organic matter type and on indicators of soil alterations is still rare. This sense it has been developed this task with the objective to investigate the restoration of soil physical property (water infiltration rate) of a degraded soil due to the building of a hydroelectric power plant. The same one has been under the influence of treatments for 17 years, using green manure, lime, gypsum, pasture and spontaneous occurrence of native species. The experimental design was a completely randomized with nine treatments and four repetitions. The treatments were: one control (tilled soil without culture) until 1999 a!

fter the implanted the *B. decumbens*; *Stizolobium aterrium* until 1999 after the implanted the *B. decumbens*; *Cajanus cajan* until 1994 and then substituted by *Canavalia ensiformis* and since 1999 was implanted *B. decumbens*; lime+*S. aterrium* until 1999 after the implanted the *B. decumbens*; lime+*C. cajan* until 1994 and then substituted by *C. ensiformis* and since 1999 was implanted *B. decumbens*; lime+gypsum+*S. aterrium* until 1999 after the implanted the *B. decumbens*; lime+gypsum+*C. cajan* until 1994 and then substituted by *C. ensiformis* and since 1999 was implanted *B. decumbens* and to two control, native vegetation (savannah) and exposed soil (without recuperation practice). The water infiltration rate was used an indicator of soil physical quality. The results were analyzed effectuating the analysis of variance, Scott-Knott to 5% of probability to compare averages. The values by water infiltration rate were higher for native vegetation and savannah followed by recovery treatment!

and the lowest value for the exposed soil, this behavior characterizes the current status and distribution pore size. In exposed soil, contains larger amount of micropores and less than macropores, which is where the water or gravitational flow, so less water infiltration rate into the soil. The soil water infiltration was useful an indicator of the improvement and different treatments of organic matter added to the soil and the action of soil tillage interact in a similar way in the recovery of soil quality.

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Short-Medium term effect of management and amendment on organic matter content and aggregate stability under wet Mediterranean climate

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Raña surfaces are common formations in the landscape of the SW Spain. They support very old and weathered soils characterized by a low pH, a low content on exchange bases, an exchange complex dominated by Al and a high content on organic matter. In the 1940's these soils were cleared for agricultural exploitation. Traditional tillage increased the mineralization rate of organic matter, resulting in a reduction of nutrient bioavailability and Ca/Al ratio, and raising Al toxicity. The first step to improve the quality of these degraded soils should consider a preliminary liming to increase base saturation and Ca/Al ratio. Direct drilling and a Ca-carrying amendment might represent good practices to achieve it. On the other hand, glomalin, which is an insoluble glycoprotein produced by micorrhizal fungi, has been related with soil structure as it has been proposed as a soil particle binding agent. However, this role is not clear in Raña surfaces due to the low pH and the high Al content. The aims of this study were to analyze in the medium term the effect of different tillage systems as well as the influence of amendment on organic matter, soil aggregation and their relationship with glomalin-related soil proteins. The study was conducted on a plinthic Paleixerult (Soil Survey Staff, 1999) in the Cañamero's raña under Mediterranean climate (mean annual temperature=15 °C; mean annual precipitation=869 mm). The experimental design was a split-plot with four replications. The main factor was management type (direct drilling versus traditional till) while the second was the inclusion or not of amendment (sugar foam plus red gypsum). Samples were collected in 2009 after four years of treatment from 0-5, 5-10, 10-25 and 25-50 cm depths; complementary samples were taken from 0-2.5 cm. Soil organic matter (SOM), particulate organic matter (POM), aggregate stability (WSA), pH, total and easily extractable Bradford-reactive soil proteins (BRSP, EE-BRSP) were measured. Analysis of variance was used to test significant differences at $p < 0.05$. Direct drilling significantly increased SOM, POM, WSA and EE-BRSP compared to traditional till in the 0-2.5 and 0-5 cm layers. Either in direct drilling or in traditional till, the amendment application slightly increased POM content in the 0-5 cm layer. In our conditions, the combination of direct drilling plus the amendment is the best management to improve soil quality as it showed the highest increments in the study variables.

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The nitrogen storage related to soil properties in clay and sandy soils of Tunisia

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Improvement of pedotransfer functions to quantify organic stocks of soils and quality of organic matters is a key to evaluate sustainability of agro-systems, especially in erodible systems of Mediterranean semi-arid areas. This work aimed to study relationships between N contents and other physico-chemical properties of clayey and sandy soils of a Tunisian data base.

The previous study of Brahim et al. (2011) on organic C (OC) stocks using structural equation modelling (SEM) showed that the clayey soils were linked to textural properties and bulk density more than chemical properties. On the other hand, OC under sandy soils was controlled by chemical more than physical properties.

This study aimed to develop two N models under clayey and sandy soils in semi-arid Mediterranean zones. To do this, we extracted 450 horizons of clayey soils and 602 horizons of sandy soils from the previous OC database. Multiple linear regressions enabled to estimate the following relationships between organic N (ON) and soil properties:

(1) clayey soils, $ON = 0.648 + 2.263 \text{ Clay} + 2.327 \text{ C-Silt} - 2.545 \text{ Db}$; $R = 0.35$, $p = 0.000 < 0.05$ (2) sandy soils, $ON = 0.161 + 7.37 \text{ MO} - 1.977 \text{ pH}$; $R = 0.322$, $p = 0.000 < 0.05$

Then, we performed a path analysis using SEM to investigate simultaneously the interactions between the different components of the soil properties and their relationships with N. Results showed that: (1) clayey model has proved that ON was significantly estimated by chemical properties and bulk density more than physical properties; ON and OC appear controlled by the same variables; (2) sandy model has proved that ON was controlled only by chemical properties, in this case physical properties has no effect on ON. These models show two possible forms of ON in clayey soils: (1) an ON fraction linked to clays and probably originated from microbial humified molecules, (2) a fraction linked to coarse silts probably originated from remaining plant debris. This model shows a negative link between ON concentration and bulk density indicating possible risks of N deficiency in compacted soils. On sandy soils, no link appears with textures, most of ON is possibly originated from organic molecules of inherited plant debris more stable at low pH than at more alkaline pH. These observations should be in accordance with mechanistic views (Pansu et al., 2010) on possible links between microbial respiration, textural fractions and pH.

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Soil carbon evolution and enzymes activity in sludge treated agricultural soil

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The application of sewage sludges to soils for agricultural or forestry purposes is the primary outlet for this type of urban waste (Albiach, 2001; Casado-Vela, Sellés et al. 2006), and also serves as a means of reducing greenhouse gases emissions as proposed in the Kyoto protocol (United Nations, 1998). The aim of this work is to assess the evolution of different forms of carbon and their relationships with enzymes activities in a Mediterranean agricultural soil.

The study was carried out in experimental plots under natural conditions, ensuring that the differences found between soils without sludge and soils which received sludge adjust to field conditions. Three types of different sewage sludge (aerobic, anaerobic and biosolid) were applied at a unique dose of 160 Mg ha⁻¹. The evolution of soil organic carbon fractions as well as the activity of some enzymes were monitored during a whole year by samples analyses in every season (spring, summer, autumn, winter).

The application of sewage sludges caused an increase in the content of organic carbon in soil. Different behaviour was observed in the evolution of carbon content over time between soils amended with aerobic, anaerobic and biosolid sludge. The carbon mineralisation was higher in the case of aerobic sludge treated soil, while for the others treatments the mineralisation was lower. In all the sewage sludge-treated soils the content of labile and recalcitrant pools of carbon were higher than in the control plots.

The dehydrogenase activity in soil increased with the application of the three types of sewage sludge, but the highest values were observed in the spring sampling for the soils treated with the aerobic and anaerobic sludges. Although the activity decreased along time, the activity was always higher in the sludge treated soils. The catalase activity followed the same trend that dehydrogenase. The data from both enzymatic activities suggests that the application of sewage sludges promotes the metabolic activity of microbial communities, thus increasing the biological fertility of the soil.

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Short-term changes in soil organic carbon contents in a low permeability and in barren land of South Korea under *Miscanthus* cultivation as a bioenergy crop

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Miscanthus is a perennial C4 rhizomatous grass, and considered for a potential bioenergy crop because it has been widely grown in East Asia and Europe. Besides, *Miscanthus* plantation has recently been a new key strategy to mitigate anthropogenic CO₂ emission while sequestering atmospheric C into soil carbon pool. Despite the potential advantage of *Miscanthus*, it has yet to clearly assess the capacity of soil carbon sequestration during *Miscanthus* cultivation. Therefore, we investigated the changes in soil carbon contents and soil chemical properties during the cultivation of *Miscanthus* growing in an unproductive land. The pilot plot (15 m X 40 m) was located in Suwon, Korea and rhizomes of *Miscanthus x giganteus* was planted at intervals of 1 m x 0.75 m in April, 2010. After 8 months after planting, we harvested aboveground biomass of senescent *Miscanthus* in November, 2010 and left its rhizome to the experimental site for the next growth. At harvest, we collected soil samples at 15, 30 and 45 cm and analyzed for soil physicochemical properties. After one-year *Miscanthus* cultivation, the pH and electrical conductivity (EC) was not changed, but soil bulk density increased from 1.55 to 1.97 Mg m⁻³. The amount of soil organic carbon along soil profiles was lower after 8-month *Miscanthus* cultivation than that before planting. Average C/N ratio of the soil profile (0 to 45 cm) increased from 8.21 to 29.1 during cultivation. Additionally, total nitrogen and available phosphorus (Bray1-P) was lowered after *Miscanthus* cultivation. Our results suggested that *Miscanthus* cultivation for a year at this experimental site had virtually no effect on soil carbon sequestration but that soil physical properties should be ameliorated to ensure soil carbon sequestration and that further investigation on the changes in soil physical properties and its associated C sequestration should be assessed.

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Does the sensitivity of the soil organic matter mineralization to a change of temperature depends on its quality?

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The decomposition of soil organic matter (SOM) is still a major source of uncertainty in predicting the evolution of atmospheric CO₂ concentration in the context of climate change. In particular, the temperature sensitivity of SOM decomposition, commonly expressed with Q₁₀, is not sufficiently known. Recent papers report contrasted conclusions about the impact of a change of temperature on soil C mineralization. The most debated point currently is whether the response of SOM mineralization to temperature is homogeneous, or depends on its quality. SOM is currently described in models with different kinetic pools, e.g. a labile pool (turnover time of several years), an intermediate pool (turnover time of several decades) and a stable pool with turnover times of several centuries or more. At present no chemical or physical method permits the isolation of these pools. Long term bare fallows (>25 years) represent a unique opportunity to determine if SOM vulnerability to increased temperature depends on its quality as with increasing duration of the treatment, the proportion of stable C relative to the total C increases (Barré et al. 2010). This is the aim of this study.

To do so, we selected samples of soils from long term bare fallow experiments from Grignon (France), Versailles (France), Askov (Denmark) and Ultuna (Sweden). These sites are part of a European Long Term Bare Fallow Network. We selected on the one hand archive samples from the start the experiments (thereby comprising different kinetic pools of C) and on the other hand samples archived respectively after 50, 80, 25 and 52 years of bare fallow (enriched in stable C).

The soil samples are incubated at different constant temperatures (4, 12, 20, 35°C) and at constant water potential (-0.32 bars), and we measure regularly the basal respiration and the origin of the carbon respired, respectively by CO₂ measurement (micro GC techniques) and isotopic ratio monitoring (GC-IRMS techniques).

Our first results indicate that the rewetted archived soils mineralize C themselves and thus that there is no need to bring an inoculum to boost microbial activity, even though the soils have been stored dry for decades. The results about the temperature sensitivity of labile versus stable SOM will be discussed.

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What is the chemical nature of stable carbon ? Using soils from a long term bare fallow to answer this question.

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Various mechanisms are developed to explain carbon stabilization in soils: (i) physical protection, (ii) protection through interaction with the soil matrix and (iii) chemical recalcitrance. Their study remains difficult as there is still no successful experimental way to isolate the stable pool of soil organic matter (SOM), i.e., SOM that has a residence time of centuries to millennia. Moreover, the relevance of the latter mechanism is currently being discussed.

A recent study showed that long term bare fallows offer a unique opportunity to study the stable compartment of SOM, as without carbon inputs and with continuing biodegradation and mineralization, SOM becomes progressively enriched in its most stable components. In the INRA 42-plot experiment that was initiated in 1928 in Versailles over 80% of total SOM is stable.

In this study we take advantage of the 42-plot long term bare fallows to (i) test the relevance of chemical recalcitrance as a long term stabilization mechanism and (ii) study the influence of physicochemical properties of the soil (different amendments) on the chemical nature of stable SOM. The techniques used are Fourier transform infrared spectroscopy (FTIR) and Curie point pyrolysis coupled with gas chromatography and mass spectroscopy (Py-GC-MS). In order to prevent the influence of decomposing plant debris, we fractionated the soil samples and analysed the fraction of particles <50µm (i.e. silt+clay).

To test the hypothesis of recalcitrance we compared the chemical nature of the soil of reference plots (no amendments) sampled in 1929 and in 2008, after 80 years. First results show that the chemical signature of 1929 and 2008 samples as seen with Py-GC-MS is significantly different whereas FTIR spectra show no differences. Py-GC-MS spectra show that alkanes and alkenes are much more present in 1929 samples than in 2008 samples. 2008 samples are characterized by the apparition of many alkylbenzenes.

To study the influence of physicochemical properties we used soils sampled in 2008 with three different treatments: (i) no amendment (ii) yearly amendment of KCl since 1929 (iii) yearly amendment of CaCO₃ since 1929. FTIR and Py-GC-MS detected no difference between the soils.

We then showed that chemical composition of silt+clay associated SOM changes as stabilization processes occur in bare fallows. Furthermore, the yearly treatments of the soils we studied (KCl, CaCO₃) did not affect the chemical nature of stable carbon.

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Agronomic performance of chickpea as influenced by trees in a Mediterranean agroforestry systems

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Agroforestry Systems (AF) may display several environmental advantages such as i) slowing down soil erosion by water and wind; (ii) increasing soil organic matter content and (iii) promoting biodiversity. In addition, the deep tree roots catch fertilizers in excess, that crops do not use and thus reduce nitrate leaching compared to monocropping systems. The introduction of a legume crop, able to fix atmospheric nitrogen (N), via a symbiotic association with rhizobium, may improve the sustainability of AF. chickpea (*Cicer arietinum* L.) productivity was monitored in AF with walnut trees during two successive years in Southern France in comparison with chickpea monoculture (MC). The aim of the study was to appreciate the agronomic performance of AF crops. For this, N plant biomass and seeds yields were estimated during two successive cultures in regard to estimations of N fixed symbiotically and released from chickpea roots by rhizodeposition. Data from AF were compared to the MC situation.

The fate of N derived from biological fixation in AF and MC were deduced by quantifying ¹⁵N natural abundance in chickpea shoots and also in shoots of wheat (season 2009) and Brome (2010) used as two non-fixing reference plants. The N rhizodeposition was measured using the ¹⁵N cotton-wick labelling method in microplots of three plants. The plants were labelled with a solution of ¹⁵N urea from the stage 6 leaves to flowering.

In AF, the chickpea yield varied according to the distance from the tree row, nevertheless, AF chickpea mean yields in 2010 (2.0 t ha⁻¹) were similar to those measured in MC (2.1 t ha⁻¹). The yield was reduced by 15.2 % if the tree rows surfaces were included in the calculation. In 2009, the % of N fixed by the symbiotic association was twice lower in AF (30.3 %) than in MC (62.6 % of total plant N, p<0.05). Similar results were obtained in 2010.

Total plant N (242.3 mg plant⁻¹) and seeds yield (5.2 g plant⁻¹) of chickpeas grown in AF microplots were higher than in MC microplots (160.9 mg plant⁻¹, p<0.05 and 2.9 g plant⁻¹, p<0.01, respectively). Total below ground nitrogen (N root + N rhizodeposition) was 24.8 % in AF and 52.9 % of total plant N in MC (p<0.05).

Our results suggest (i) a good agronomic performance of AF based on leguminous crops, and (ii) a better N nutrition of the plant via a higher availability in mineral N for AF.

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Management-specific distribution and stabilization of organic carbon within macroaggregates from arable soils

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The storage potential for soil organic carbon (SOC) is significantly influenced by soil management strategies, which directly affect structure formation processes associated with modified carbon turnover leading either to carbon losses (CO₂ emissions) or long-term stabilization of carbon in soils. How far soil management (crop rotation, tillage systems) can improve the physical protection level of organic carbon, e.g. by reducing the microbial activity within aggregates or by physical occlusion of the carbon sources, has been investigated for macroaggregates of different size classes (5-8, 8-12, 12-25mm aggregate diameter), which are most sensitive to tillage practices due to their lower stability. Undisturbed air dried single aggregates obtained from various arable soils in Western and Northern Germany (Luvisols from loess and glacial till) were peeled by rotating in single erosion chambers into three separated concentric layers of equal solid mass ratio (%) representing the exterior, transitional and interior region. In addition to organic carbon contents mechanical stabilities of single layers were determined from the abrasive forces, which were required for peeling the aggregates from the outside to the inside. Depending on management system and aggregate size class differences in carbon distribution could be identified. While in most cases we found a gradient of decreasing SOC from outer to inner regions the variation differed depending on aggregate size and pre-ceeding crop. Furthermore, local mechanical stability within aggregates enables general predictions about their physical stabilization potential for organic carbon. Thus more stable aggregates tend to result in higher carbon retention. Ongoing research on soil structure dynamics and pore space characteristics using non-invasive μ CT imaging will allow insights into soil structure – carbon relations at greater detail for a better understanding of carbon gradients and turnover in aggregated arable soils.

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Chemical composition of soil organic matter stored in cryoturbated arctic soil

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Cryoturbation is one of the main mechanisms responsible for the huge carbon storage in arctic soils. The subduction of carbon-rich, poorly decomposed top-soil horizons into deeper soil layers, leads to a strongly retarded decomposition of this organic matter and therefore to an exclusion from the short-term carbon cycle. To evaluate whether the chemical composition of soil organic matter (SOM) was affected by subduction and which compounds were most sensitive to decomposition under these conditions we subjected different soil horizons from Greenland and Siberia to pyrolysis-GC/MS. Our results demonstrate that organic horizons, irrespective whether recent or old (subducted) clustered together, and were separated from mineral horizons. The separation was mainly driven by the pyrolysis products of carbohydrates and lignin, which were correlated with organic horizons and lipid-derived and aromatic compounds, which were correlated to mineral horizons. The similarity of recent and subducted organic material indicated a high potential of the subducted horizons to become a major source of easily decomposable carbon for microbial decomposition if physicochemical conditions in deeper soil layers change in a future climate. Differences between top-soil organic material and subducted organic material, mainly observed as an altered carbohydrate to lignin ratio, point to an ongoing decomposition in cryoturbated soil parts, but at very slow rates or as a result of altered decomposition processes (e.g. different microbial communities). The results will be discussed with regard to microbial community data derived from PLFA analysis.

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Manganese effect on lignin degradation degree in beech (*Fagus sylvatica* L.) leaf litters

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Lignin content exerts a major control on litter decomposition. Among the factors affecting lignin degradation, manganese (Mn) may play a key role. Correlations between Mn concentration and litter decay rate were previously reported and explained by the role of Mn²⁺ in the catalytic cycle of manganese peroxidase, an enzyme of the lignin degrading system secreted by the white-rot fungi.

However, the influence of contrasting Mn concentrations on lignin degradation in leaf litters has not yet been directly tested. This study aims to assess the effect of Mn concentration on the lignin degradation degree of decomposing beech leaves.

Beech leaves were experimentally enriched in Mn and incubated (i) in situ for 500 days using a litterbag experimental design and (ii) in vitro for 300 days under laboratory controlled conditions. On selected incubated leaves (the Mn-poorest and Mn-richest branch (2.1 and 6.6 mg.g⁻¹) and seedling leaves (0.9 and 17.0 mg.g⁻¹), we determined C and N concentrations as well as the degradation degree of leaf litter after analysis of lignin-derived phenolic compounds by CuO oxidation.

At the end of incubation, lowest carbon concentrations were recorded in leaf litters with the highest Mn concentrations. This could be explained by an improvement of ligninolysis and thus, an easier access to C previously embedded in the lignin matrix. The lignin unit concentrations (estimated by the sum of CuO oxidation products VSC) were significantly lower in in situ incubated Mn rich leaf litters, where microbial communities could freely respond to the change of substrate properties. The (Ac/Al)V and (Ac/Al)S ratios, indicating lignin alteration, were larger in Mn rich leaf litters. The S/V and C/V ratios, indicating the preferential S and C degradation, were expected to decrease with lignin degradation. We did not observe these trends in our data, which indicated that our leaf litters had still been in the early stage of decomposition process.

We conclude that the ligninolysis improvement by Mn is already observable in the early stage of litter decomposition and is mediated by the biotic environment in which decomposition takes place.

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Session 2

**Advances in physical and biological techniques to
study soil interfaces**

Mineralogical effect of FAO particle size analysis procedure

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Particle size distribution is a critical feature of soils determining its physicochemical properties. Therefore grain size analysis requires suitable sample pretreatments to obtain reasonable distribution results. FAO offered such a method including removal of organic matter, carbonates and iron oxides, hydroxides in order to attain proper dispersion of soil grains. Hungarian standard demands only sodium pyrophosphate while FAO procedure contains treatments of hydrogen peroxide, hydrogen chloride and sodium dithionite. Applying the two different methods the grain size distribution differed from each other. This discrepancy inspired to study soil mineralogy in details.

We examined 100 samples of 23 soil profiles from West-Hungary representing the most common soil types in Central-Europe, mostly brown forest soils. Semiquantitative mineral composition was determined by X-ray powder diffraction before and after the pretreatments. Clay mineralogy was studied on the <2 µm fraction using several clay mineral diagnostic method. We compared the treated and untreated samples by thermal analysis as well.

Mineral content of the soil samples is characterized by quartz, feldspars, calcite, dolomite and goethite. The <2 µm fraction includes chlorite, kaolinite and illite, as well as swelling smectite, mixed layer illite/smectite and chlorite/vermiculite.

We found the decrease of 1.4 nm reflection and the simultaneous increase of 1.0 and 0.7 nm peaks in the bulk soil sample after FAO pretreatments. The sum of the phyllosilicate clay minerals increased, the treatments resulted doubled amount of soil clay in average. However, the ratio of 0.45 nm clay mineral and 4.25 nm quartz reflections has not changed significantly, which indicates clay mineral transformation beside the dispersion of colloid grains during the procedure. According to X-ray diffractograms of the <2 µm fractions, the intensity of swelling (1.4 nm) and illite (1.0 nm) clay minerals reflections increased. The latter one was more intensive indicating transformation of swelling clay into illite type mineral. Thermal analysis of the bulk soil suggested similar phenomenon. Alteration of expandable clay minerals into non-expandable ones is proved by the decrease of interlayer water loss of the treated vermiculite or smectite.

Concluding our results, the original clay mineral content, especially the swelling particles went through transformation during the pretreatment stages of FAO particle size analysis.

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Extraction of low molecular organic acids and siderophores from soil analysed by liquid chromatography mass spectrometry

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Low molecular mass organic acids (LMMOA) and siderophores are molecules secreted by mycorrhiza and have previously been found in soil solution and in cultures. Mycorrhizal fungi are suggested to be involved in the nutrient uptake processes of trees and weathering of minerals. In this study soil samples taken from the O and E horizons of a podzol were extracted with 10 mM potassium phosphate buffer at pH 7.2. Variable parameters included addition of methanol to the extraction buffer and the use of ultrasonication or rotary shaking during extraction. LMMOA and siderophore content of the soil extracts were determined. Analysis of soil extracts were carried out by liquid chromatography mass spectrometry (LC-MS) and the extraction results were compared to results for soil solution obtained by centrifugation of the sampled soils. 17 LMMOAs were determined with the highest contents of citrate, fumarate, ketoglutarate, lactate, malate, oxalate, pyruvate and shikamate. Of the siderophores analysed, only ferricrocin was found in all samples, while ferrichrome was occasionally registered. The extract contents were significantly increased by addition of methanol to the extraction buffer, especially for the O horizon samples. Of the LMMOAs, the content of citrate was most increased by the addition of methanol. Rotary shaking of the samples for 90 minutes gave slightly higher contents than ultrasonication for 15 minutes, but the reduction in extraction time makes ultrasonication an attractive option.

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Assessing litter quality by ^{13}C -CPMAS NMR predicts decay rate better than C/N and Lignin/N ratios

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Leaf litter decomposition is a crucial process for carbon and nutrient cycling in terrestrial ecosystems. Temperature and water availability are considered the most important environmental factors affecting litter decomposition rates at global scale, whereas litter quality is a factor controlling litter decay rate at local scale. Traditionally, litter quality is defined using the C/N or the lignin/N ratios as predictors of decay rates. Here, we propose a more predictive index of litter quality, based on experimental evidences. Sixteen plant litter types, treated in microcosm under controlled conditions for 180 days, were used in a litter-bag decomposition experiment. Litter samples were chemically characterized by ^{13}C CPMAS NMR and for C, N and lignin content. Litter mass loss of all species followed a negative exponential dynamic and decay rate largely varied among the 16 species. Initial litter lignin/N and C/N ratios largely varied between the species, and C/N ratio significantly decreased for all species during the decay process. The NMR spectra showed the O-alkyl-C region, mainly associated with sugars and polysaccharides, largely decreased after the first 30 days of decomposition. In parallel, the aliphatic alkyl-C region, related to lipid waxes and cutins, increased sharply in the first 30 days of decomposition and slowly in the later stages of decomposition. A statistically based comparative analysis of spectral regions and C/N and lignin/N showed that litter decay rates depend on dynamics of selected organic C, corresponding to O-alkyl C (61-90 ppm), methoxyl C (46-60 ppm), and aliphatic-alkyl C (0-45 ppm), being more significantly correlated to restricted spectral fraction of each region. The ratios C/N and lignin/N, showing different trends of correlation with decay rates at different decomposition stages, can be used to describe the quality of undecomposed litter, but are unable to predict mass loss of decomposing materials. A multiregressive model based on ^{13}C -CPMAS NMR predictors, cross-validated by using two randomly selected sets of litter types, showed highly fitting predictions of observed decay rates, showing that organic matter quality can be reliably described by ^{13}C -CPMAS NMR data throughout the decomposition process.

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SOMDY: a new model of carbon sequestration based on C chemical quality by ¹³C CPMAS NMR and physical aggregation of organic matter

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The potential of agro-ecosystems to absorb large quantities of atmospheric carbon dioxide through carbon sequestration in the form of soil organic matter (SOM) is increasingly considered as a mitigating options for climate change. The ecosystem carbon storage depends not only on C inputs, but also on its outflows due to SOM decay rate. SOM decomposition is affected by climatic variables, SOM quality, and soil disturbance. Temperature and water availability are considered the most important factors acting at global and regional scale. On the other hand, at local scale, where climate can be considered relatively uniform, SOM decay rate has been reported as mostly affected by C quality. In this work, a new model of SOM decomposition is presented. The model is based on a novel implementation of SOM quality described by ¹³C-CPMAS NMR to purposely overcome the limitations of traditional applications of C/N ratio and to include the effects of physical aggregation of organic matter. The model was calibrated on data of CO₂ emissions from extensive field experimental measurements. The simulation results showed the model capability to predict changes of SOM quantity and status during decomposition processes, including the effects of addition of organic amendments (e.g. compost applications and green manure) as well as the impact of different tillage practices. Also, the model outputs on physical structure of soil aggregation have been successfully compared with field observations.

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The potential of NIR spectroscopy to predict the soil texture and mineralogy in the Cerrado Latosols

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The determination of soil properties based on laboratory analysis is time and cost consuming. Reflectance spectrometry techniques have been accepted as a fast and non-destructive screening method to evaluate soil properties, which is considered as possible alternatives to replace conventional laboratory methods. The infrared spectroscopy (IRS) allows for simultaneous characterization of various soil chemical properties, such as the contents of soil C, N, P, K, Ca, Mg, microelements or particle size distribution. However, only very few studies applied IRS as a predictor of the mineralogical content of the soils. In this way, the objective of this study was to investigate the potential use of near infrared reflectance spectroscopy (NIRS) as a tool for diverse soil properties assessment over a wide range of Latosols in the Cerrado region (Central Brazil). As these soils have undergone pronounced desilication, the dominant residual minerals, i.e. kaolinite, gibbsite and goethite, play a key role in soil functioning, through their effect on the sorption of nutrients and the stabilization of organic matter. Therefore, a specific attention will be paid on the prediction of these minerals in the soils. A population of 148 soil samples was taken from 0 - 0.2 m and 0.6 – 0.8 m soil depth from 74 sites situated in Goiás, Mato Grosso and Minas Gerais States. The samples were scanned with a spectrophotometer (Foss NIRSystems 5000). Modified partial least squares (mPLS) were used to develop the calibration models between reference data and NIRS spectra. About 60 % of the samples were selected according to their representativity for the calibration set, and the remaining samples were included in the validation set. The results indicate that particle-size fractions (especially clay content with a coefficient of determination in calibration (R^2_{CAL}) = 0.83 and a coefficient of determination in validation (R^2_{VAL}) = 0.74) were correctly estimated. Several soil properties that do not have a primary response in the near-infrared region, such as CEC and Ca were accurately predicted by the NIRS due to the correlation of these properties with soil organic matter content. Good results were obtained to calibrate the mineralogical content of the soils, both relative to the contents determined by thermogravimetric analysis (TGA) or after extraction with sulphuric acid (SA), with R^2_{CAL} ranging from 0.68 to 0.90 and R^2_{VAL} ranging from 0.74 to 0.86 for kaolinite, gibbsite and goethite.

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Molecular identification of fungi isolated from municipal sewage sludge

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Fungi are important in terrestrial decay processes. However, fungi associated with waste, among other sewage sludge are still not well known. In this study molecular identification methods were used to identify fungi isolated from municipal sewage sludge to gain a better understanding of the diversity of fungi associated with this waste.

The aims of this research was to determine the species of fungi that can grow and degrade organic compounds of sewage sludge. The research were conducted by carrying out isolation and identification of fungi from municipal sewage sludge. Fungal communities in sewage sludge were assessed with molecular identification using comparative rDNA sequencing of the LSU D2 region. The MicroSEQ® ID software were used for assess raw sequence files, performs sequence matching to the MicroSEQ® ID validated reference database and creates Neighbor-Joining trees.

The results suggested that fungi were capable of growth in the municipal sewage sludge and participated in degradation of organic compounds of this waste. The results indicated the large diversity of fungi in municipal sewage sludge. Isolated fungi belonged to the yeast and filamentous fungi.

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An automated continuous flow ^{13}C and ^{15}N labelling system to estimates the ^{13}C and ^{15}N flow of enriched root exudates in the soil solution of crop rizospheres

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Little information exists on the flows of C in the rhizosphere of crop systems. A closed automated continuous labelling system was developed and tested to follow the flow of $^{13}\text{CO}_2$ and ^{15}N in the plant and ^{13}C and ^{15}N in the soil solution from canola (*Brassica napus* L) and wheat (*Triticum aestivum* L) rhizosphere. The isotope labelling system consisted of four closed mixing chambers where $^{13}\text{C}+^{12}\text{CO}_2$ flows was computer controlled. The soils in the planted pots were injected with $^{15}\text{NH}_4\text{NO}_3$ or $\text{NH}_4^{15}\text{NO}_3$ and sealed to prevent diffusion of ^{13}C into soil pores from the chamber atmosphere. At the beginning of labelling, the labelling system scrubs the $^{12}\text{CO}_2$ content to $50 \mu\text{mol mol}^{-1}$ air prior to injecting $^{13}\text{CO}_2$ to reach a final concentration of $360\text{-}400 \mu\text{mol mol}^{-1}$ (atom% $63.4\pm 4.6\text{-}88.2\pm 4.9\%$). During isotope labelling, the computer program control the injections of $^{13}\text{CO}_2$ (98 atom % $^{13}\text{CO}_2$) in amounts equivalent to those consumed by the plants. Monitoring and recording of $^{13}\text{C}+^{12}\text{CO}_2$ was done each second using a LI-7000 infrared gas analyzer (IRGA) calibrated to measure $^{13}\text{CO}_2$. Our results showed that there was no $^{13}\text{CO}_2$ diffusion into the sealed planted soil pots as indicated by $\delta^{13}\text{C}$ signature. Continuously injected $^{13}\text{CO}_2$ was assimilated at a rate between 0.0022 ± 0.03 and $0.047\pm 0.009 \mu\text{mol mol}^{-1} \text{min}^{-1} \text{plant}^{-1}$ for canola and wheat. After two hours of labelling the $\delta^{13}\text{C}$ atom % in excess of shoots and roots of canola ranged from 3 ± 0.05 to $47.9\pm 3.4 \mu\text{g }^{13}\text{C plant}^{-1}$ and for wheat between 0.2 ± 0.03 and 6.0 ± 1 . These values for ^{15}N were $17.4\pm 0.01\text{-}210\pm 10 \mu\text{g g}^{-1}$ soil for Canola and $1.5\pm 0.01\text{-}90.4\pm 5$ for wheat. The amount of ^{13}C in the soil solution in both crops ranged from 0.71 ± 0.27 and $0.77\pm 0.47 \text{ng g}^{-1}$ soil and for ^{15}N between $4.2\pm 0\text{-}1$ and $330\pm 65 \text{ng g}^{-1}$ soil. Shoots, roots and soil solution were more enriched ($P < 0.01$) after 6-h labelling. This finding has important implication for a better understanding of the C flows from roots into soil solution after short periods without the interference of soil microbial processes. Our closed continuous flow system offers considerable potential for in situ C and N tracer investigations in soil rhizospheres.

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Visualisation and modelling of water-air interface in soil porosity: impact on microbial degradation

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The high level of heterogeneity at the pore scale caused by soil structure may lead to a spatial disconnection between soil carbon and nitrogen, energy sources, and the organisms that are involved in carbon transformations. The goal of this work is to carry out measurements at the microscopic scale with simultaneously modelling processes in order to study the influence of small scale pore space architectures and water/air distribution on the decomposition of organic matter in inter-aggregate pore volumes. Fresh aggregates of a loamy soil (2-3 mm diameter) equilibrated at a water pressure of -300 cm of water were compacted at 1.8 g/cm³ in a cube of 1 cm³. A water pressure of -5 cm of water was then applied at the bottom of the sample. The sample was scanned at a voxel-resolution of 4.43 μm at the Synchrotron radiation microtomography (XMCT) facility operated by the GKSS research centre at HASYLAB (Hamburger Synchrotron Strahlungslabor) belonging to the DESY (Deutsches Elektronen Synchrotron) in Hamburg, Germany. In large pores, menisci of water were visible. Two pore-scale modelling approaches were used to simulate water distribution in pores of the 3D images. The two-phase TRT lattice Boltzmann scheme is based on the Shan-Chen approach implementing attractive fluid-fluid short-range interactions to simulate surface tension forces and on the Martys approach implementing attractive or repulsive fluid-solid interactions to simulate hydrophilic or hydrophobic surfaces. In MOSAIC (Modelling Of Soil microbial Activity Investigated by Computer vision) the pore space is described using a minimal set of maximal balls (Delaunay spheres). The balls may be full of water or air according to their size and location using Young-Laplace law. 3D images of water/air distribution in the pore space simulated by Mosaic and the two-phase TRT LBM were compared to those obtained with XMCT in order to evaluate the voxel-based approach (LBM) and the morphological approach (MOSAIC) in terms of reproducibility of the water/air spatial distribution in the pore space. Degradation of organic matter was further simulated with MOSAIC at 2 water pressures: -5 and -300 cm of water in order to compare decomposition by microorganisms at these 2 water pressures.

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The role of microorganisms in the association of soil organic matter with minerals: a ^{13}C labeling and HPLC-IRMS approach

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Soil mineral-organic associations retain up to 80% of the soil carbon, but the mechanisms of association remain largely misunderstood. We hypothesized that the microbial processing of plant residues facilitates their incorporation within mineral-organic associations. To test this hypothesis, we tracked the ^{13}C derived from labelled leaves in microbial biomarkers (amino sugars) within different mineral-organic associations.

^{13}C -beech litter (3.1% excess) incubations were conducted at 20°C in the laboratory for twelve weeks on a Cambisol collected from the 0-2.5 cm depth horizon of an acidic beech forest, what is equivalent to eight months *in situ*. Soils were density fractionated so as to separate plant debris (<1.65 g.cm⁻³), plant aggregates (1.65-1.85 g.cm⁻³), microbial aggregates (1.85-2.4 g.cm⁻³) and mineral grains with little organic matter (>2.4 g.cm⁻³). Soil fractions were successively hydrolyzed, filtrated and purified using a cationic exchange resin to isolate amino sugars, used as biomarkers of bacterial (galactosamine and muramic acid) and fungal (glucosamine) biomasses. Carbon isotopic composition of amino sugars was determined by high performance liquid chromatography coupled with an isotope ratio mass spectrometer (HPLC-IRMS).

Amino sugars represented 2% of total soil carbon, less than 1.5% of the carbon associated to aggregates and up to 3% of the carbon associated to mineral grains. They indicated the dominance of bacteria over fungi. After twelve weeks of leaf litter decay, more ^{13}C tracer was incorporated in amino sugars found in plant debris and plant aggregates than in microbial aggregates and mineral grains. In all fractions, bacteria were more efficient than fungi incorporating the carbon derived from leaf litter. Our results suggest that the microbial processing of plant residues is an important stage prior to association with minerals. Complementary NanoSIMS and STXM-NEXAFS investigations supported this later finding.

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Humic acids from Podzols under mountain pine in various stage of degradation – FTIR and ¹³C NMR study

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Fourier Transform Infrared (FTIR) as well as ¹³C NMR techniques allow to analyze structure and composition of humic acids' molecules. Application of these methods in organic matter studies has become a valuable tool to developing knowledge of humic substances and to better understand processes that occur in the environment. Aim of this work was to analyze elemental composition and structure of humic acids extracted from organic and mineral horizons of Podzols from the subalpine region of East Sudety Mountains, Poland. Ecosystems in this part of Poland suffer due to negative human activity what appears in deforming of needles and gradual process of dying trees. Main causes of these changes are air pollutions and trans boundary acid rainfalls which were a serious problem in last decades. Soil samples were taken from altitude 1300-1400 m a.s.l., under mountain dwarf pine without degradation signs, with about 50% of yellowing needles and degraded without needles. In the most degraded ecosystems natural plant communities are replaced by subalpine meadow which influence the properties of soil organic matter. Elemental analysis was performed for C, H, N with a Perkin-Elmer 2000 instrument. Fourier transform Infrared (FTIR) spectra were recorded with a FTIR Bruker 66/s spectrometer. Solid-state ¹³C NMR spectra of humic acids (CPMAS NMR) were obtained using a 300 MHz AMX Bruker NMR spectrometer. Elemental composition, atomic ratios of humic acids indicate that degradation processes and changing of plant community affects the lowering of carbon and nitrogen in humic acids' molecules in organic and mineral horizons. In humic acids an increase of internal oxidation (ω) under the influence of degradation processes was also observed. Spectroscopic analysis point to an increase of carboxyl and aromatic C contribution in molecules of humic acids from the most degraded ecosystems.

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Understanding Phosphorus (P) dynamics in soils amended with repeated application of different organic amendments using the Diffusive Gradients in Thin-films (DGT) technique.

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Global P resources are limited, and as they are exploited, they are gradually depleting. Each year over 85% of mined phosphate rock is used in agriculture as a fertiliser for crops or as an additive to animal feed. Organic amendments can help provide a sustainable alternative to traditional inorganic fertilisers, which are becoming increasingly expensive due to resource scarcity concerns. However the concentration of phosphorus in organic amendments is variable and its availability when applied to soils is relatively unknown. This makes farmers less confident of the reliability of organic amendments when used to meet crop nutrients demands. Knowledge of their P availability can reduce reliance on inorganic fertilisers in agriculture. Currently the most common and widely used soil tests to measure soil P are extraction techniques (for example Olsen-P). However there are problems with these, mainly P availability is over predicted. The Diffusive Gradients in Thin-films (DGT) technique is an alternative P test which can measure the form of P which is available to the plant, reflecting diffusional supply from the soil solution and its replenishment from the solid phase. The technique can mimic plant P uptake by creating a well-defined sink for P. If the DGT technique can help improve understanding of soil P dynamics following application of organic amendments, it can be used as a tool to make phosphorus use in agriculture more sustainable. The objectives of the current study are as follows (1) To quantify plant available P pools in soil associated with application of different organic amendments (cattle slurry, cattle manure and green waste compost) and estimate the timescale required to make P available to plants. (2) To quantify plant response to available P in relation to different application rates (0, 75, 150 mg/kg P) of the various organic amendments. (3) To quantify the kinetics of phosphorus release from the solid phase to solution in soils amended with different organic amendments. Work to date has shown that: (a) DGT gels can be successfully and consistently produced in the laboratory; (b) DGT can be successfully deployed in soils which have received application of organic amendments and show consistent results; and (c) when comparing DGT P with Olsen-P, the P content analysed is lower in the former than latter which can be associated with the passive sampling approach in DGT as opposed to chemical extraction in Olsen-P.

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Identifying genes involved in potassium-bearing mineral weathering by thermophilic fungus *Aspergillus fumigatus*

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In order to study the weathering mechanism of potassium-bearing mineral by fungi at molecular level, we prepared differential expression cDNA libraries using suppression subtractive hybridization (SSH) technology for *Aspergillus fumigatus* cultured with or without potassium mineral. Among genes of mineral induced expression, 24% are involved in carbon source consumption, while genes of repressed expression, 54% belong to membrane proteins. The study showed that the factors could accelerate weathering of K-bearing mineral involved organic acids, carbonic acid and redox molecular. The K-bearing mineral can induce up-regulated expression of carbonic anhydrase (CA), implying that *A. fumigatus* is capable of converting CO₂ into carbonate to accelerate potassium-bearing mineral weathering, which fixes atmospheric CO₂. During mineral weathering, fungal metabolism changed, produced more metal binding proteins, reduced membrane metal transporter expression, thus modulated ion absorption and disposal, and promoted acid production. This study increased the understanding about the mechanism by which microorganisms weather silicate minerals. Since silicate weathering consumes CO₂ in geological history, the current study provided molecular evidence for the participation of microorganisms in silicate weathering and carbonate formation.

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Fast Field Cycling NMR relaxometry: a new tool to assess the effects of organic amendments on a agricultural soil from Southern Italy

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One of the most worrying aspects of intensive agriculture is the gradual decrease of soil fertility due to organic matter (OM) loss. The delicate balance between OM accumulation and consumption must be positively retained in agricultural systems in order to prevent soil fertility reduction. The maintenance or even an improvement of soil fertility as well as OM content, can be achieved through the use of different organic amendments.

Structural and conformational OM characteristics can be analysed by high field (HF) nuclear magnetic resonance (NMR) spectroscopy either in the solid or in the liquid state. In both cases, information on the chemical nature of OM can be achieved.

Relaxometry studies can provide information on the molecular dynamics of natural organic matter. However, HF-NMR relaxometry limitations are related to the strength of the magnetic fields which limits the range of relaxation rates that can be investigated. In fact, high magnetic fields (e.g. ≥ 108 Hz) reduce the possibilities to observe molecular dynamics at very low frequencies such as those between 106 and 103 Hz. To this aim, nuclear magnetic resonance relaxometry at low fields and in the fast field cycling (FFC) setup is the most powerful way to retrieve information on the dynamics at low frequencies. Here, FFC-NMR relaxometry studies on soils subjected to different organic amendments are presented.

Two farms, with different soil properties, in an important agricultural area of Campania Region, Italy, were selected in order to apply different organic amendments on bulk soils. To understand their effects on soil OM, after one year amended soils were sampled, dried, sieved, and, analysed by FFC-NMR relaxometry.

In this study, an innovative application of spectroscopic technique, as FFC NMR relaxometry, to soil allowed to obtain interesting information on the effects of organic amendments on soil properties. In particular results suggest that the amendments induced an increase of the soil pore size, by organo-mineral aggregates formation, which, in turn, can have positive effects on soil structure and soil aggregation.

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Exogenous isolation of Inc-P1 plasmids from copper-affected soils

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Chile is a main copper producer in the world. Important increases in copper soil levels have been reported in areas located in the vicinity of mining activities, affecting both soil quality and biology. Copper is an essential micronutrient to all organisms. However, at high concentrations, copper is also a toxic element, leading to the generation of hydroxyl radicals that damage cellular biomolecules. In response to high copper concentrations, bacteria have developed resistance mechanisms, generally encoded in mobile genetic elements (MGEs). MGEs contribute significantly to the diversity and adaptability in response to selective pressure created by human activities. Plasmids belonging to the IncP-1 incompatibility group have received much attention in recent decades. These plasmids are self-transmissible, and transfer to and replicate in a wide range of hosts. All known IncP-1 plasmids have similar backbone regions. Moreover, they carry different accessory modules which have been shown to encode either antibiotic/ metal resistance or enzymes involved in degradation of xenobiotic compounds. The objective of the present study was to screen copper-polluted soils for the presence of IncP-1 plasmids. Soils were collected as composite samples from four locations situated a variable distance from a copper smelter in the Aconcagua river basin, Valparaíso region, Chile. Total soil DNA was extracted from 0.5 g using the FastDNA® Spin Kit for soil (MP Biochemicals). The crude DNA extract was purified by using the GeneClean® Spin® Kit (MP Biochemicals). Metagenomic DNA was used as target for PCR-based detection of IncP-1 backbone sequences. Presence of IncP-1 sequences was confirmed by Southern blot analysis. IncP-1 plasmids were detected in all the analyzed soils. Hybridization with specific probes for different IncP-1 groups demonstrated that IncP-1 plasmids ϵ are the most abundant. In a triparental mating, two transconjugants carrying IncP-1 plasmids were isolated in one of the studied soils. Current work involves the molecular characterization of newly isolated IncP-1 plasmids. Our results demonstrated that metal-affected soils could represent a reservoir for the conjugative IncP-1 plasmids. Their abundance could contribute to the adaptation of bacterial communities to metal pollutants.

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Molecular characterization of novel *Stenotrophomonas* sp. strains isolated from a copper-affected agricultural soil

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Copper is an essential trace element for both eukaryotic and prokaryotic cells. However, copper at elevated concentrations can be toxic to plants and soil organisms. To tightly regulate intracellular copper concentrations, bacteria have developed mechanisms of copper resistance and homeostasis. The study of the bacterial metal resistance and their mechanisms provides valuable information for the development of strategies for their removal from the environment. The aim of this study was to characterize copper resistant strains isolated from an agricultural soil from Central Chile affected by mining activities. Isolates were able to grow in Tris minimum media containing up to 250 mg l⁻¹ Cu²⁺. Multi-copper oxidase gene *copA* was detected by PCR amplification in all strains. For identification, multi-locus sequence analyses (MLSA) utilizing 16S rRNA gene as well as DNA gyrase β -subunit (*gyrB*) and RNA polymerase sigma factor (*rpoD*) housekeeping genes were amplified by PCR and sequenced. 16S rRNA gene sequence analyses indicate that isolates possessed 98.9% similarity with *Stenotrophomonas maltophilia*T. The *gyrB* sequences of the *Stenotrophomonas* isolates were 93.9% and 90.2% similar to *S. rhizophila* and *S. chelatiphaga* sequences, respectively. Sequence similarities between the *rpoD* gene between of our isolates and those of *S. rhizophila* and *S. chelatiphaga* were 90.5% and 90.2%, respectively. The 16S rRNA, *gyrB* and *rpoD* sequence analysis suggest that the isolated strains probably comprise a distinct and novel species of *Stenotrophomonas* and these resistant bacteria are possibly specialized colonists of these contaminated soil environments. Moreover, MLSA is a reliable method of elucidating taxonomic data to inform *Stenotrophomonas* speciation in isolates from environmental origin.

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Sonochemical effects in solutions of humic substances

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Humic substances (HS) exist in the water-soil medium. HS are basic component of the soil humus and has great importance for soils; they condition, stabilize and correct them structure. They penetrate also for natural waters. In their compositions HS present 60-80% total organic matter. SH due to their sorption ability of many harmful organic pollutants produced by human and their ability of forming complexes with heavy metals, are removed from water during its treatment. Also, HS are known to form trihalomethanes (THM) upon final chlorination. HS are ineligible in drinking water and that sanitary norm indirectly define. Mainly, HS are removed from the water by the conventional coagulation. Chemical oxidation is an alternative technology that has been successfully supplied for destruction of a broad spectrum of organic compounds, HS also. Intermediate oxidation is intended to degrade toxic micropollutants, remove THM precursors and increase biodegradability. Ozone and hydrogen peroxide applies most often. Chemical oxidizing in both cases can be more forceful at additional employment of ultrasound. Ultrasound could be responsible of sonolytic degradation of the organic molecule and causes sonolysis of the oxidant molecule to create potent oxidizing free radicals.

The combination of ultrasound and ozone US/O₃ for removal of HS from water, was studied. An ultrasonic generator was performed UP-400S (24 kHz) of useful power 300 W. The amount of the acoustic energy inserted into the medium and the height of the ultrasound field intensity were controlled by changeable time of sonification (t=5-20 minutes) and the change of a vibration amplitude in ranges (A=18-90 mm). The intensity was high up to 100 W/cm². Dose of ozone amount to 1-5 mg/dm³. As the samples we prepared a solution of commercial humic acids HA (Fluka) in deionized water (10-20 mg/dm³). Efficiency of researched process was analyzed on base of change, before and after process, parameter following: TOC, DOC, UV₂₅₄, colour, oxygen consumption. Due to the application of US/O₃ process the decrease of researched parameter was observed. With the reference to the obtained results it is possible to conclude that the US/O₃ combined process was more effective in degrading HS than each process separately (synergetic effect). The most favorable reduction of the content of HA compounds was observed for higher intensities of the ultrasonic field.

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Session 3

Dynamics of pollutants in soil systems and bioremediation

Bacillus cereus, a model for studying the impact of climate changes on food borne pathogens in soils? Preliminary experiments

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In the context of Climate Change, the increase of frequency and intensity of droughts, heat waves and heavy rains may impact soils and the service they provide through changes in the successions of edaphic microbial communities. Moreover in this climatic context, soils that welcome pathogens may change their ecological niches to them. The soil borne bacterium *Bacillus cereus* is also a food borne pathogen, with a genetic structure corresponding to groups with different temperature growth abilities and different degrees of virulence. The global evolution of the *B. cereus* Group seems to be strongly determined by ecological adaptations. Given these ecological traits, *B. cereus* is an interesting model for studying the impact of climate change on food borne pathogens. Our problematic deals with the impacts of climate change and extreme events on the selection, growth and transfer of *B. cereus* strains living in soil. Little attention has been paid to analyse the biological and ecological properties that are tightly related to the specific thermal characteristics of this pathogen in its natural environments (i.e. soil and ground water). In consequence, we propose to develop methodologies (experimental design and microbiological and biomolecular methods) to follow strains of *B. cereus* in soils and in water percolated from soils. Vegetative cells and spores of *B. cereus* were inoculated separately and at different concentrations into an agricultural Mediterranean soil and into underground water collected from a karstic system, and incubated in standardized conditions of temperature and humidity. During the following days and weeks, we measured bacterial concentration evolution with microbiological methods (vegetative cells and spores) and quantitative PCR (after development of DNA extraction procedures) targeting the *B. cereus* Group. The next step of this original study will be to investigate the impacts of high temperature and drought, simulating heat Mediterranean waves, on the evolution of *B. cereus* population in soil microcosms and thereafter their transfer through soil columns exposed to rainfall of controlled intensity.

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Heavy metal availability and their relationships with soil microbial characteristics in agricultural carbonated soils

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Heavy metal availability and their relationships with soil microbial characteristics were evaluated in 10 agricultural carbonated soils that were artificially polluted with heavy metals. Soils were spiked with Cd, Cu, Zn and Pb at two contamination levels corresponding to current EU legislative limits for agricultural soils and sewage sludge. Soil properties related with availability of heavy metals were measured. Available heavy metals (0.1 M NaNO₃, 10 mM LMWOA and 0.005 M DTPA), total DNA load, fungal DNA load, bacterial DNA load, dehydrogenase (DEH), arylsulfatase (ARYS), β-galactosidase (BGAL), urease (URE) and alkaline phosphatase (ALP) activities were determined. Total DNA load was significantly lower in spiked samples than in control samples. Fungal DNA load showed no significant differences between treatments, while bacterial DNA load decreased significantly in all spiked soil samples. BGAL and URE activities decreased significantly in both contamination levels. ARYS, ALP and DEH were significantly inhibited at high dose contaminant level. Pearson's correlations were calculated between microbial characteristics and soil properties. ARYS activity correlated positively with organic matter in all treatments and with Fe-Mn oxides in high dose contamination level. BGAL and ALP activities showed positive correlations with Fe-Mn oxides in all treatments, but negative correlations with carbonates in high dose level. DEH activity correlated with water soluble C in control soil samples. However, correlation analysis showed no clear effects of contaminants on DNA loads and enzyme activities. In contrast, simple biological ratios were significant correlated with extractable metals (ARYS/N, URE/C, URE/N, URE/total DNA, DEH/C, DEH/N, DEH/total DNA or total DNA/C). Redundancy Analysis (RDA) was carried out. Microbial parameters were used as species and extractable metals and soil properties as environmental variables. Microbial parameters distribution pattern was mainly related to DTPA extractable Cd, Cu and Zn and LMWOA extractable Pb. Soil properties as Fe-Mn oxides, CEC, carbonates, total P and recalcitrant organic C determined samples dispersion. Our results showed these microbial parameters as good indicators of heavy metals contamination and indicated that the limits of current level proposed by the EU for these heavy metals strongly affect soil microbial properties.

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Phosphorus removal by using mineral soils from the Antofagasta region in the north of Chile

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Phosphorus (P) pollution is a worldwide concern due to cause eutrophication in aquatic environments. This concern has generated interest in the use of different treatment technologies to remove P from contaminated water. Sorption in mineral soils is a cost effective system successfully used to remove different pollutants. Depending on the clay composition and the physicochemical properties, mineral soils have shown different capacities for removing dissolved P from wastewater. The aim of this work was to evaluate the removal of P by using mineral soils from the Antofagasta region. Three soil samples were taken from different locations: Antofagasta (AN), Mejillones (ME) and Calama (CA), and passed through a 2 mm mesh. Organic matter (OM) and pH were measured. X-ray diffraction (XRD) was used for the soil mineralogical analysis. Batch adsorption assays of P were carried out in order to obtain the optimal pH, kinetic and adsorption isotherms. P concentration was measured using the molybdate blue colorimetric method. The OM content was 0.3, 2.3 and 1.3% in the AN, ME and CA soils; the pH values were 7.1, 8.2 and 7.8, respectively. XRD analysis showed a wide variety of minerals. Chlorite and calcite were detected in all the soils studied. In the AN soil, chlorite and calcite were 10.3 and 29%; in the ME these were 5.0 and 4.5%; and in the CA they were 3.1 and 15.4%, respectively. Illite was only detected in the CA soil (20.7%). Zeolite was detected in the AN soil (4%). Muscovite was detected in the AN (14.6%) and ME (11%) soils. The sorption of P increased with the pH increase. In a pH range between 4.0 and 7.0, the sorption increased from 0.29 to 4.02 mg g⁻¹ in the AN soil, from 0.42 to 3.9 mg g⁻¹ in the ME soil, and from 0.33 to 0.93 mg g⁻¹ in the CA soil. The sorption of phosphorus was higher in AN ≥ ME > CA. The high capacity of P removal in the soils could be related to the high content of calcite and chlorite minerals. Calcite is associated with the fixation of P in alkaline soils; meanwhile, P is fixed by interlayer hydroxides of chlorite. The OM could have influence in the sorption of P in the soils. Depending on the mineralogical composition, mineral soils have the potential to remove dissolved phosphorus from water. The use of AN and ME soils presents an attractive alternative for P removal; however, more studies are required to evaluate the industrial use of these mineral soils in water treatment procedures.

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Heavy metals removal from water using aquatic plants (*Nasturtium officinale* and *Mimulus glabratus*)

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The use of plants to extract, immobilize and detoxify pollutants is known as phytoremediation. This technology is an ecological alternative for the remediation of soil, water and wetland. Most plant species growing in contaminated sediment or waters have the capacity to accumulate pollutant and therefore can be used in phytoremediation. The aim of this work was to evaluate the capacity of *Nasturtium officinale* and *Mimulus glabratus* to accumulate heavy metals. *Nasturtium officinale* plants were grown under laboratory conditions. *Mimulus glabratus* plants were obtained from the Toconao valley in the Antofagasta region of Chile. The assay was developed using a nutritive solution containing a mix solution of Cu, Zn and Pb (0, 1 and 2 mg l⁻¹). In the first experiment, 2 g of fresh matter of each plant was put in contact with a mix of heavy metals. The plants were removed at 10 days. In the second experiment, 140 g of fresh matter of each plant was put in contact with a solution mix of 1 mg l⁻¹. The stop time was determined according to the symptoms of the plants. Dry matter (DM) and Cu, Zn and Pb concentrations were measured. In the first experiment, when *Nasturtium officinale* was used, a decrease in DM was noted with an increase in the heavy metals concentration from 120 to 90 mg pot⁻¹. When *Mimulus glabratus* was used, DM increased from 160 to 200 mg pot⁻¹ for 0 and 1mg l⁻¹ respectively, and then decreased to 120 mg pot⁻¹ for 2 mg l⁻¹. Heavy metals accumulation in plant tissues increased with the increase in the concentration. For *Nasturtium officinale*, it increased from 0.013 to 0.162 mg Zn pot⁻¹, from 0 to 0.08 mg Pb pot⁻¹, from 0 to 0.14 Cu mg pot⁻¹. For *Mimulus glabratus*, it increased from 0.01 to 0.02 mg Zn pot⁻¹, from 0 to 0.2 mg Pb pot⁻¹, and from 0.01 to 0.44 Cu mg pot⁻¹. In the second experiment, when *Nasturtium officinale* was used, the stop time was 30 days, the final DM was 530 mg pot⁻¹; meanwhile, for *Mimulus glabratus*, the stop time was 50 days, and the final DM was 550 mg pot⁻¹. The concentration of heavy metals in *Nasturtium officinale* tissue reached 0.18 mg Zn g⁻¹, 0.18 mg Pb g⁻¹ and 0.23 mg Cu g⁻¹. Higher concentrations of heavy metals were found in *Mimulus glabratus* tissue: 1.16 mg Zn g⁻¹, 2.68 mg Pb g⁻¹ and 3.16 mg Cu g⁻¹. *Mimulus glabratus* presented a higher content of heavy metals; therefore, it can be considered an attractive alternative to study for use in phytoremediation systems.

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Evaluation of the Suitability of Using High Amounts of Urban Wastes for Degraded Arid Soils Restoration and C Fixation

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Soil degradation and desertification is a serious worldwide problem, particularly in arid and semiarid areas, where the common factor of their soils is the low level of organic matter. On the other hand, the elimination of the increasing production of municipal waste is an environmental and logistics challenge that demand powerful and innovative solutions environmentally friendly that are both economic and viable. This poses a synergistic solution of two problems, which passes through the use of urban waste as a strategy for the recovery of soil quality. The aim of this work was to establish whether it is possible to use high doses of organic waste for the recovery of degraded semiarid soils helping to soil C fixation without causing negative effects on soil quality. We focus on the association of organic matter to soil fractions of different particle sizes. To this aim, a degraded soil from SE Spain was amended at rates of 150 (d1) and 450 t/ha (d2), with a mixture of municipal solid waste and sludge at three different levels of stability (fresh material, FR, and composted for 30, FC, and 60 days, MC,) and submitted to an incubation period of nine months under controlled conditions. In the whole soil, no significant differences among organic amendments were observed at d1. However, at d2 the soil C content showed a defined gradient (MC > FC >> FR). It was also noted that all the amended soils showed higher humic substance C content (HS) than the control soil, the differences with control in soils amended at d2 being twice those of soils amended at d1 at the end of the incubation. Soils amended with the composts at d2 showed higher HS carbon content than that amended with FR. As regard soil particle-size fractions, C and N contents increased with diminishing particle size in all treatments, MC d2 treatment showing the highest C and N contents at the end of the experiment. However, the behaviour of the different enzymes studied (dehydrogenase, β -glucosidase, aminopeptidase and polyphenoloxidase) in soil particle fractions differed depending on each enzyme. The heavy metals contents in both the sludge and compost were below the limits established by the EU for sludges and soils. The results demonstrate that the addition of high doses of amendments to degraded soils is an effective and synergic strategy for the elimination of urban waste disposal and the restoration of semi-arid soils helping to soil C fixation, particularly when composted wastes are added.

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Fractional distribution and dissipation of pentachlorophenol in the rhizosphere of rice (*Oryza sativa* L.)

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Phytoremediation is an emerging technology for the remediation of organic soil pollutants such as pentachlorophenol (PCP). To investigate the rhizosphere effects on the fractional distribution of PCP and their dynamic changes, a glasshouse experiment was conducted by using specially designed rhizobox where rice seedlings were grown for 45 days. The soil was spiked with two PCP levels at 20 ± 0.5 and 45 ± 0.5 mg kg⁻¹, respectively. Soil in the rhizobox was divided into five different compartments at various distances from the root compartment. Sequential extractions of PCP were conducted by using three extractants CaCl₂, Butanol and DCM. CaCl₂ removes polar & soluble neutral form of PCP, while butanol extraction was a feasible method for microbial mineralization especially bacterial mineralization prediction. Harsh extractants, such as DCM were generally used to quantify the total amount of PCP in soil by a single extraction. Results demonstrated that butanol extractable form of PCP showed significant higher concentration as compared to other two extractable fractions of PCP at different distance from root. Among three different fractions after 45 days of rice transplantation, the polar & soluble neutral form of PCP was significant higher at 4 mm and 5 mm distance from root at 20 and 45 mg kg⁻¹ PCP treatments, respectively. Butanol extraction showed that significant difference at 3mm distance from root at both levels of PCP. DCM extractable form of PCP showed significant difference at 5 mm distance from the root at two different treatment levels of PCP. After 15 days, significant higher concentration of polar & soluble neutral form of PCP was found as compared to control as well as other two fractions of PCP, but its concentration decreased with the increase of time. We found significant higher concentration of Butanol extractable form of PCP as compare to other extractable form of PCP after 45 days. In DCM extraction after 45 days the PCP concentration significantly decreased at both 20mg kg⁻¹ and 45mg kg⁻¹ PCP treatments as compared to control. The results suggested that the effect of root proximity is important on the fractional distribution as well as on the dissipation of xenobiotics such as PCP in soil.

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As-species in agricultural soils with long-term fertilization

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Introduction. The long-term fertilization of agricultural soils very often leads to As-accumulation in soils. But the assessment of the ecological consequences of this phenomenon can be done only on the base of analysis of As compounds in soils. They provide the influence of different soils on plants.

The objects and methods of investigation. There were investigated three Podzolic soils of Moscow region with different granulometric composition (silty clay loam, silty loam, sandy loam). They have been fertilized during 50-70 years. The fractionation of As species in soils was fulfilled by using of some extragens: 1% (NH₄)₂ SO₄- (for exchangeable species, I), 1M CH₃COONH₄- (specifically adsorbed, II), 0.5 M NH₄F-(for species bond with Al and partly with organic matter, III). The combined extragent of Mehra-Jackson was used for extraction of As-Fe species (IV). As content in soils and extragents was determined by AAS- method.

Results. The average total As content in soils consists of 9.8 mg/kg in silty clay loam soil and 5.8 mg/kg in sandy loam soil. As-Fe species dominated among As species in soils. The content of I, II, III As forms (% from the total As content) did not differ in the soils with different granulometric composition.

The long-term fertilization of soils did not change sufficiently the total As content in soils as the content of I, II, III As species. As far as the more mobile As species (I, II, III) it can be supposed that the short-time increasing of these species content has taken place but it was could not be registered after the harvesting. But the content of As-Fe species sufficiently increased in the soils that have received different fertilizers for a long time. At these conditions the content of Fe (hydro)oxides increased. This phenomenon takes place because of the weathering of soil minerals in situ under the influence of fertilizers.

Conclusion. The long-term fertilization of agricultural soils by different types of NPK fertilizers was not accompanied with the sufficient increasing of total As content in soils. The increasing of the content of As-Fe species in agricultural soils was caused by the weathering of soil minerals under the influence of long-term soil fertilization. This phenomena has the great significance because it provides the strong fixation of As and the reduce the negative impact on the agricultural plants.

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Background content of hydrocarbons in taiga zone soils

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The background contents of hydrocarbons (HCs) in soils of the far-northern and northern taiga of the Komi Republic were assessed. It was found that the soils of accumulative landscapes are enriched with HCs in comparison with the soils of eluvial landscapes. The differentiation of the HCs among the soil genetic horizons is more pronounced in the soils developed on loamy parent rocks (gley-podzolic and bog-podzolic soils) and less pronounced in the soils developed on sands (podzols and humus-illuvial bog-podzolic soils). The organic, litter, and illuvial horizons serve as a geochemical barrier in the pathway of the HCs migration within the soil profile. A database for the mass fractions of HCs in the soils was created using GIS technologies (ArcView GIS 3.2a), and a sketch map of the HCs distribution in the soils was developed on its basis. The results obtained for the background content of HCs are used for assessing the contamination of soils with oil and oil products and for gaining ecological expertise in the development of regional deposits of natural resources (raw hydrocarbons). This work was supported by the Russian Foundation for Basic Research (no. 11-04-00086-a).

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Assessment of Soil Degradation Risks Caused by Priokhotie Mining Industry and the Role of Humus Substances in Soil Recultivation

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Soil cover degradation in Priokhotie causes irreversible physical and chemical changes in soils. Dump reclamation with organogenic (organo-mineral and other) soil layers accelerates sod pedogenesis and technogenic soil formation, in most cases characterized with formation processes, different from those of disturbed soils. Due to the absence of sod pedogenesis on the steep slopes (>10 degree) at the initial stage of technogenic soils formation, the filled up layer thins to 7 cm: a) in P-3 an organogenic layer is rapidly decomposed; b) in P-1 an organo-mineral layer is rapidly washed out through a large pore space into the supporting layers. Direction of soil forming processes depends on the specifics of a layers used for recultivation. The use of coarse organogenic layers intensifies the formation of aggressive humus fulvic acids, processes of fersiallitization and the formation of ferri-ferrous films on the sides on peds. Organo-mineral complexes in humous soil layers used for land reclamation foster the processes of alluvial and humus discharge and formation of drip humus-ferri-ferrous inter-aggregate films. Thickness of diluvia deposits plays a significant role in technogenic soil formation on the gentle slopes and impacts the length of permafrost processed and the formation of a zone of capillary-suspended moisture. Appearing anaerobic processes most often cause gleization inside the peds and misbalanced Fe secretion on the ped sides.

Mining impact on the soil cover, when exceeding the permissible level, disturbs soil formation processes. Accumulating transformations misbalance soil structure sustainability and may lead to the complete degradation and losses of fertile forest soils. Existing norms for permissible soil losses at mining are derived from average observation data at some mining developments. The real situation is more complicated. The method to calculate the permissible soil degradation rate (annual per area unit) or quantitative assessment of soil self-regulation processes have not been worked out yet.

The results revealed that a disturbed soil localization index is of the chief importance for soil degradation assessment. Soil degradation rate in the investigated territory appeared to be different. Chemically contaminated soils degrade slower due to self-regulation processes, whereas mechanically disturbed soils have higher rate risks and need ecological and engineering measures.

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Calcium Sulfate effect on Nutrient Content and Antioxidant Activity in Highbush Blueberry Subjected to Phytotoxic Aluminum

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Blueberry (*Vaccinium corymbosum* L.), demands acid soils ($\text{pH} \leq 5.5$) for their optimal growth, but in Andisols it is sensitive to phytotoxic aluminum (Al^{3+}) liberated by the acidity. This causes a reduction on nutrient uptake, and an increased oxidative stress. Currently, calcium sulfate (CaSO_4) is used to ameliorate this toxicity, because it practically not changes the soil acidity reducing the Al -phytotoxicity. However, the physiological or biochemical effects of this compound on blueberry remain unknown. The aim of this work was to study the CaSO_4 effect on mineral content, oxidative stress and antioxidant capacity of blueberry cultivars growing under acidic conditions.

Legacy and Bluegold blueberry cultivars were grown in nutritive solution ($\text{pH} 4.5$) and subjected for 15d to following treatments: control (1); 2.5 mM $\text{CaSO}_4 + \text{Al}^{3+}$ 100 μM (2); 2.5 mM $\text{CaSO}_4 + \text{Al}^{3+}$ 200 μM (3); 5 mM $\text{CaSO}_4 + \text{Al}^{3+}$ 100 μM (4); 5 mM $\text{CaSO}_4 + \text{Al}^{3+}$ 200 μM (5); Al^{3+} 100 μM (6) and 200 μM (7). Thereafter, calcium (Ca), sulfur (S) and Al content, lipid peroxidation (LP), radical scavenging activity (RSA), and total phenol contents (TPC) were evaluated in leaves and roots.

In Bluegold, leaf Ca and S concentrations increased from 25 to 33% respectively compared to control in treatment 5, whereas in roots concentrations were reduced by treatments 6 and 7. In both cultivars, CaSO_4 reduced leaf Al concentration between 65 and 78%. Oxidative stress was decreased in Legacy and Bluegold when added CaSO_4 , especially in treatments 4 and 5; in contrast 6 and 7 treatments showed a strong increase of LP (~55%) respect to control. Results showed that LP were correlated with Al content in leaf ($r = 0.80$; $P = 0.031$). In Legacy roots and Bluegold leaves LP showed a correlation with Ca ($r = -0.90$; $P = 0.005$ and $r = -0.82$; $P = 0.046$, respectively) CaSO_4 significantly increased RSA ($P \leq 0.05$) of Bluegold leaves in treatments 2 and 5 respect to control and was correlated with LP only in leaves of Legacy ($r = -0.86$; $P = 0.024$). Levels of TPC increased with CaSO_4 (treatments 2, 4 and 5) compared to control ($P \leq 0.05$). A relationship was observed between TPC and S content in leaves of Legacy ($r = 0.85$; $P = 0.014$) and Bluegold ($r = 0.89$; $P = 0.017$). In both cultivars CaSO_4 had positive effects on reduction of Al and LP due to improved level of Ca and S, being associated with higher antioxidant activity.

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Effect of different vermicompost tea on zink, iron and phosphorus concentration and uptake in wheat

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Global population progressive increase and accepting excessive production of livestock, disposing the wide range of animal waste matters is a serious problem throughout the world and it is usually the main source of environmental pollution. Some treatments can be preparing these wastes to apply in soil and safe repulsion in environment. Vermiwash is lateral product of vermicomposting process which contains nitrogen, phosphorous and many micronutrients, hormones; etc. Among the factors responsible for low yield, inadequate nutrient supply plays an important role. The quality and quantity of wheat can be increased by adopting the physiological manipulations through the foliar sprays of humic acid sources i.e., vermiwash. Present investigations were carried out during the year 2009 - 2010 at University of Tehran, The purpose of this study was evaluating methods of compost tea on Zn, Fe and P content in wheat (*Triticum aestivum* L.) grain. A green house experiment was conducted in a factorial randomizes complete block design (RCBD) with four replicates. The treatments were: 1- 15 type of compost tea (including: various substrate 1-Mature Vermicompost (MV) 2- Immature Vermicompost (IV) 3- Composter Worm (CW), and also various species extractor including: 1- distilled water with pH=5 (Wt5) 2- distilled water with pH=7 (Wt7) 3- distilled water with pH=9 (Wt9) 4- DTPA (full strength) 5- DTPA 1/3 strength). Vermiwash was sprayed on plants seven times for two weeks after planting and fresh vermiwash was applied. After harvest, biological, grain and straw yield and 1000 grain weight were measured. Grain and straw samples were sent to soil and water laboratory and concentration of N, P and K were determined. The study revealed that combination organic fertilizers vermiwash combination compared with control and chemical fertilizers had great influence on plant growth parameters. The maximum biological yield of wheat during the trial demonstrated a greater response in comparison with the control by 8/8%. The fruits were found to have a greater percentage of iron, zinc and phosphorus content when compared with those grown with chemical fertilizers by 52.68, 13.22% and 8/9% respectively. The results illustrated that the type of vermiwash hadn't significant difference on Zn, Fe and P concentration on wheat grain. Overall it is economically preferable to apply distilled water rather than DTPA and chemical fertilizer. This biological method of crop cultivation is sustain...

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The role of metal accumulation in the laurel forest of La Gomera (Canary Islands, Spain)

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Plants growing in soils that are rich in potentially toxic metals have developed different mechanisms to resist or tolerate toxicity. These mechanisms include hyperaccumulation, which is defined as the ability of certain plants to accumulate extremely high levels of metals in their tissues. Volcanic ash soils (Andosols) are often strongly acidic and produce aluminium toxicity in the roots of sensitive plants. This toxicity is mainly attributed to Al³⁺ from hydroxy-Al interlayered 2:1 silicates because of its rapid release kinetics. Atlantic laurel forest is currently found growing in volcanic ash soils on the archipelagos of the Azores, Canaries and Madeira and is thought to be a relic of the tropical flora inhabiting the Mediterranean Basin during the Miocene-Pliocene. The levels of Al, Mn and other metals in the tissues of laurel forest trees have been reported to be very high, but are so far considered a primitive feature related to the relict nature of the laurel forest.

The present study investigated the content of Al and various heavy metals in soils and plant tissues of a subtropical laurel forest in the Canary Islands and their relationship to the composition and structure of the forest. The content of different Al-fractions and bioavailable (NH₄Ac-EDTA extractable) metals was analysed in a large number of soil samples and related to lithological and topographic factors. Seasonal variation of the metal content in the soil, phytomass and litter was studied at sites with different degrees of maturity or sites affected by forest dieback. Extremely high levels of bioavailable Al, Fe and Mn were observed in soils. The Al and Mn levels exert a considerable influence on the ecosystem composition. The results of this study reveal the bioaccumulation of Al in *Ilex canariensis* and *Viburnum rigidum* and suggest the accumulation of Mn in *Laurus novocanariensis*. The bioaccumulation patterns of Al are closely related to the NH₄Ac-EDTA-extractable soil content, while they are not as closely tied to KCl-extractable Al, thus suggesting the greater importance of humic complexes in the regulation of aluminium toxicity in comparison with hydroxy-Al interlayered 2:1 silicates. Bioaccumulation gives rise to Al-rich litterfall inputs, allowing the exclusion of Al-intolerant species from the understory or neighbouring vegetation.

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Changes of humus, caused by interactions with heavy metals

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Introduction. Under the increasing pollution of environment by heavy metals (HM) we need the information about their influence on the quality of soils. The purpose of this study is to investigate the influence of the interaction of HM with humus acids (HA) on the acid-base soil properties, on the humus state of soils.

The objects and methods of investigation. The objects of this study were two groups of soils. The first group was represented by some Podzolic soils. Their water extracts were investigated by the methods of potentiometric titration: by acid, base, by the solutions of HM salts. The second group was represented by the upper horizons (0-20 cm) of Podzoluvisol and Chernozem. The preparations of HA and products of their interaction with Cu salts were investigated. The following properties of HA and HA-Cu complexes were determined: molecular-masses distribution (MMD), infrared spectra (IRS), hydrophobicity, ¹H NMR spectra.

Results. In the water extracts of the first group of the soils pH level ranged from 4, 14 to 6, 34. Water solutions of the pure salts of metals Cu(NO₃)₂, Pb(NO₃)₂, Zn(NO₃)₂, HgCl₂, Fe₂(SO₄)₃ had acid reaction (pH 5,12-2,47) because of their hydrolysis. To the end of potentiometric titration of the water extracts by the solutions of HM salts pH levels became lower than both: water extracts and solutions of the HM salts. It was the result of the formation of complexes of HM with HA.

The experiments with HA of the second group of soils have shown how the properties of HA have changed due the formation of their complexes with HM. The MMD of HA has changed: the increasing of the content of fractions < 10 cDa was accompanied by the increasing of Fe, Al, Ca, Mg content in them. The changes of ¹H NMR evidenced the increasing of the content of the unsubstituted aromatic structures. It is supposed that the named changes were caused by partial removal of long aliphatic chains from the aromatic rings.

Conclusion. The formation of complexes of added HM with HA led to the changes of important soil properties. The acidity of soil solutions increased. The structure of HA disrupted. These processes are classified as degradation of humic substances.

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Exploration of Environmental Changes as a Result of Anthropogenic Influences at Watery Habitats

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Nowadays natural habitats are imperilled because of human landscape-transformer processes and negative effects of climate change. Watery habitats belong to the most vulnerable lands because low rate of anthropogenic effects can lead to significant and fast changes in these places.

Although we can characterize Carpatian Basin with high mosaicity, it is need to be managed in its entirety without borders. The international realization of the project is supported by the Hungary-Romania Cross-Border Co-operation Programme of the European Union in 'Exploration and Comparative Analysis of the Effects of Regional Climate Change at Watery Habitats' project (HURO/0901/207/2.2.2). Lake Nagyszéksós (sodic lake, Mórahalom, SE Hungary) and Püspökfürdő (karst lake with thermal spring-water, Oradea, NW Romania) are two examined areas with different environmental conditions. In contrast with 'Püspökfürdő' Lake Nagyszéksós is touched by anthropogenic effects in lower degree.

Conditions of two watery habitats and anthropogenic effects in dynamics of environmental and ecological processes are examined in the project. Paleoecological analysis, soil- and wather-chemical measurements and geological examinations are carried out in the areas. Based on laboratory measurements and field studies we are able to do comparative analysis, prepare parameter-maps and examine the evolution of the areas.

Aims of our work are to classify ecological potential, to define the rate of degradation and to determine ecological function of the natural habitats; during the project the changing of parameters are also observed.

Ecological changing forecasts can be created by using results of the research. These forecasts can promote the development of a sustainable land use concept in case of Lake Nagyszéksós, character and quantity of investments can be determined according it. Results give possibility to sustainable development of tourism investments and operation in case of Püspökfürdő, what assists the improvement of ecological status of the lake.

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Investigation of Slope Sediment of Red Clay Rendzina

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Nowadays the geochemical investigation of soils has received increasing attention owing to the significant role played by both their mineral and organic composition in the processes of pedogenesis, in the migration of contaminants and in the global carbon cycle. Detailed knowledge of the organic and inorganic geochemistry of soils is needed to study different soil-chemical processes and to determine geochemical boundaries. This work is a part of a project aiming at the geochemical characterization of the soil types of Hungary.

Objectives of this work were to investigate mineral and organic geochemical characteristics of soil of slope sediment coming from red clay rendzina (RCR) on the basis of element distribution (XRF) in the soil profile, to characterize soil organic matter by Rock-Eval pyrolysis and to examine the effects of climatic conditions in connection with weathering processes. Samples were collected from a red clay filled doline on karst-plateau of Aggtelek-Rudabánya Mountain (NE Hungary).

Both warm humid and temperate climatic conditions are indicated by the main mineral composition during pedogenesis. These conditions are shown by contrary tendency in kaolinite content of latosol and red clay residuum and in the presence of hematite which give the red colour to RCR. Besides kaolinite vermiculite and smectite were detected by XRD in deeper horizons, therefore we supposed that magnesium originated not only from dolomite but mostly from Fe-Mg-silicates, which could also be the source of the Fe-content of hematite. The Cu-, Zn- and Pb contents all exceed the Hungarian norm in the whole profile. This load is natural because the presence of Cu together with Zn, Pb indicates ore formation. Bulk Rock-Eval data show the general soil organic matter evolution trend and the early stage of the transformation of bio-macromolecules into humic substances.

The source material was generated by long, multi-phased weathering processes taking place in different micro-environments as evidenced by the inorganic geochemical results. These processes started in warm and humid environment. On the basis of organic and inorganic geochemical examinations, geochemical boundaries are at 10 and 40 cm. The signs of pedogenesis in the upper 40 cm of the studied profile suggest the lack of reworking during sliding down on the slope.

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Variation on photosynthetic performance and its relationship with antioxidative systems in perennial ryegrass cultivars exposed to manganese excess

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In Southern Chile, large areas of pastures are sown in Andisols, half of which have high acidity levels. In such soils, manganese (Mn) excess is recognized as one of the most important factors that limits crops growth. Excessive plants Mn levels cause oxidative stress, chlorophyll biosynthesis inhibition and a decline in the photosynthetic rate. Previously, we demonstrated that high Mn concentrations induced oxidative stress in perennial ryegrass (*Lolium perenne* L.) and that antioxidant activity of enzymes, especially superoxide dismutase (SOD), increased in response to Mn excess, mainly in tolerant cultivars. There are no reports regarding the effect of Mn excess on photosynthetic process in this forage and how these effects can be related to plant antioxidative systems. Here, we studied the effect of increasing Mn supply on photosynthetic performance and antioxidative responses in perennial ryegrass cultivars with contrasting tolerance levels to Mn toxicity. Seedlings (10-old-day) of cv. Nui (Mn-sensitive) and cv. Kingston (Mn-tolerant) were grown in a greenhouse under nutrient solution conditions at four Mn doses: 2.4 (control), 50, 150 and 350 μ M. After 21 days, plant growth, Mn uptake, lipid peroxidation (LP), radical scavenging activity (RSA), total phenolic (TPH) content, SOD activity, CO₂ assimilation, chlorophyll fluorescence parameters of photosystem II and pigments content were measured. Confirming our earlier results, we found that despite both cultivars showed similar values of Mn uptake, growth reductions and LP levels were higher in Nui. In both cultivars, RSA, TPH contents and SOD activity enhanced at increasing Mn supply. As expected, Mn-tolerant cv. Kingston showed the highest values for all these parameters. Effective quantum yield and electron transport rate were reduced at increasing Mn doses, being both more affected in Nui compared to Kingston. Also, we found that only in Nui but not in Kingston, CO₂ assimilation decreased at increasing Mn concentrations. Results allow suggest that oxidative stress status is strongly related to photosynthetic response to Mn excess in ryegrass. Therefore, we concluded that RSA within with antioxidant enzymes (such as SOD) has a key role on the tolerance to Mn toxicity in ryegrass plants, which protect them against Mn-induced oxidative stress, permitting a better photosynthetic performance under Mn excess in this forage species.

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Key soil factors influencing the transfer of 17 elements from soils to young leaves of Tieguanyin tea in the south of Fujian Province, PR China

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The transfer characteristics of elements between soils and plants are indispensable for establishing benchmarks of toxic elements in the soil. The soil-to-plant transfer factor (or accumulation factor, concentration factor) is usually used to compare the ability among different plants to accumulate elements from soils. It has been revealed that the soil-to-plant transfer factor is not a constant for a given plant species and element but a variable varying with the concentration of the element in the soil. However, it is not clear whether the soil-to-plant transfer factor is dependent on the physical-chemical properties in the soil. In order to understand better the soil factors that significantly affect the soil-to-plant transfer factor of elements, we studied the transfer characteristics of nutrient or toxic elements (N, K, Ca, Mg, S, Mn, Fe, B, Mo, Cd, Pb, Zn, Cu, Cr, As, Ni, Se) from the soil to the youngest leaves of Tieguanyin tea in the south of Fujian Province, China. An investigation over 150 Tieguanyin tea plantations was carried out. 150 samples of the surface soils (0-25 cm) and 150 corresponding young leaves (the uppermost 2-3 leaves) of Tieguanyin tea were collected. The total contents of N, K, Ca, Mg, S, Mn, Fe, B, Mo, Cd, Pb, Zn, Cu, Cr, As, Ni and Se in the soils and the tea leaves were determined. The alkaline hydrolysable N, exchangeable K, Ca and Mg, DTPA-extractable Cu, Pb, Zn, Mn, Fe and Ni, water-soluble B and Mo, CaH₂PO₄-extractable S, HCl-extractable Cr and Na₂HPO₄-extractable As were measured as available pools of the elements in the soils. The pH, CEC, organic matter content and the particle composition were also determined. The transfer factor based on total content in the soil (TFT_{Total} = the concentration of an element in tea leaf/the total concentration of the element in the soil) and the transfer factor based on available content in the soil (TFA_{avail} = the concentration of an element in tea leaf/the available concentration of the element in the soil) were calculated.

The results showed that the transfer factors based on the total contents of all the elements decreased with the increase in the total amounts of the element in the soil and were better described by power function ($y = ax-b$). The TFT_{Total} values of Cd decreased with the increase in CEC and OM in the soil, those of Mg decreased with the increase in CEC, OM and silt (0.02-0.002 mm) content, those of Ni and B decrease with the increase in clay content. The transfe...

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Degradation of chlorpyrifos by actinomycetes isolated from soil

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Chlorpyrifos is an organophosphates pesticide highly toxic and widely used in soil and foliar as insecticides. Considerable attention has received the potential of contamination by pesticides. Contamination of soil can result from bulk handling in the farmyard, and rising of containers and accidental release could occasionally lead to contamination of surface and groundwater. The use of actinomycetes is an attractive approach to be use in bioremediation, since these microorganisms are diverse and nutritionally versatile bacteria found in a wide range of habitats, present metabolic diversity and rapid rates of growth, therefore may be well suited for bioaugmentation of decontamination systems.

The goal of this work was to evaluate the degradation of chlorpyrifos by actinomycetes isolated from agricultural soil. The highly-pesticide tolerant strain, *Streptomyces* sp. strains AC-5 and AC-7 were evaluated for degradation of chlorpyrifos applied at concentrations of 25 mg L⁻¹ and 50 mgL⁻¹. The flasks were incubated at 28 °C in a rotary shaker. Samples were taken out at 24, 48, 72 and 96 h. and analyzed for biomass, residual chlorpyrifos and analysis of the main metabolite of chlorpyrifos, 3,5,6-trichloro-2-pyridinol (TCP).

The results of this study showed that chlorpyrifos was rapidly degraded by actinomycetes. Strain AC-5 degraded 98 % of chlorpyrifos after 96 h of incubation with a half-life of 17 h. Similarly, strain AC-7 degraded between 97-98 % of chlorpyrifos with a half- life of 14 h. However, a different metabolism of degradation was observed. Strain AC-7 presented a production between 5-11 % TCP and 3-14 % TCP respect to an application of 25 mg L⁻¹ and 50 mg L⁻¹ chlorpyrifos, respectively, with an increment of production in the time. By contrast, strain AC-5 showed a TCP production less than 3 %, not found residues after 96 hours. The degradation of chlorpyrifos was favored by the culture medium containing glucose, as this insecticide is degraded by co-metabolism. On the other hand, there would be an adaptation of these microorganisms to degrade chlorpyrifos since they were isolated from a soil with history of chlorpyrifos application. With these results we can consider the use of actinomycetes as biotechnological tools for the decontamination of pesticides.

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Combined effects of nitrogen and sulfur fertilization on selenium accumulation and antioxidant capacity in ryegrass plants.

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Selenium (Se) is a micronutrient with antioxidant properties for animal and human health. In higher plants Se function is controversial, but there are many biochemical evidences showing a decrease of the oxidative damage under abiotic stress conditions. The Se content in soils and pastures of Southern Chile is deficient, and the application of Se-fertilizers to the soil-plant system has proven to be beneficial for animal health. In this work, we report the effect of seed pelletization with selenite (0, 30 or 60 g/ ha) on Se uptake and antioxidant responses of ryegrass (*Lolium perenne* cv. Quartet) at different nitrogen (0 or 100 mg N/ kg) and sulfur (0, 50 or 100 mg S/ kg) fertilization rates. The results showed that shoot Se concentration increased significantly due to the application of selenite. Nevertheless, Se accumulation in the shoots slightly decreased when N or S was applied. The level of lipid peroxidation was also reduced as a consequence of N and S fertilization at the highest Se supply. This response coincided with a trend to increase the antioxidant activity (DPPH) in plants treated with 100 mg N/ kg and 60 g Se/ ha. In addition, the activity of the antioxidant enzyme superoxide dismutase (SOD) of Se-treated plants diminished by the combined effect of N and S at the highest doses. In contrast, without N addition, the application of 100 mg S/ kg and 60 g Se/ ha increased the oxidative stress in ryegrass plants. Therefore, depending of the N and S fertilization rates, ryegrass seeds pelletization with selenite could be used not only to increase the Se content of pastures, but also to improve the plant antioxidant system in Se-deficient areas.

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Sorption of the new herbicide aminocyclopyrachlor by cation modified clays

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Aminocyclopyrachlor (6-amino-5-chloro-2-cyclopropyl-4-pyrimidinecarboxylic acid), a new DuPont herbicide, has been recently approved by US-EPA for the control of broadleaf weeds, grasses, vines and woody species in non-crops, turf, sod farms, and residential areas. Due to its dissociation constant ($pK_a = 4.65$), it is in the anionic form at typical soil pH levels. Anionic pesticides are generally weakly retained by most soil and sediment components and potentially can reach and contaminate surface and ground waters. One strategy to minimize the risk of water pollution associated with weakly sorbed, highly mobile pesticides is the application of these herbicides together with a sorbent, such as modified clays, i.e. mineral clays exchanged with inorganic and organic cations. The aim of this work was to determine the ability of unmodified and modified clays to sorb aminocyclopyrachlor. Two montmorillonites (Ca-Arizona montmorillonite (SAz-1), and Na-Wyoming montmorillonite (Swy-2)) were used as unmodified clays and were also modified with an inorganic cation (Fe^{3+}), soil clay constituents (ferrihydrite, humic acid), and organic cations (hexadecyltrimethylammonium (HDTM2), hexadimethrine, spermine). Higher sorption of aminocyclopyrachlor was observed in the sorbent-solution systems with lower pH values, presumably due to protonation of the herbicide anion at low pH and sorption of molecular species on noncharged areas of the clay. FeSwy-2 (system pH = 4.6) was found to be the best sorbent for aminocyclopyrachlor (86% of applied). The best organoclay (SA-HDTM2) (system pH = 6.1) sorbed 53% of the applied herbicide. Soil clay constituents (system pH > 6.7) did not sorb aminocyclopyrachlor. Modification of mineral clays with inorganic and organic cations, and their use as herbicide sorbents can be an efficient strategy to reduce the risk of surface and ground water contamination associated to anionic and highly mobile herbicides.

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Description the soil buffering disturbance in pesticides polluted soils

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The soil's recharge ability plays an important role in the bioavailability of compounds necessary for plants. On one hand these compounds are taken away from the soil solution by plants, while on the other hand ground water removes them, causing decrease in amount and concentration. The buffer capacity of a compound referring to a given soil uniquely determines the effective diffusion, mass flow and bioavailability of the compound. This quantity is given by the first derivative of sorption isotherms as a function of the equilibrium concentration. If the measured as well as the modeled multi-step isotherms are considered the resulting function will form a wave-shaping like function. The common properties of these functions that the maximal values can be even ten times larger than the minimal values in the 5 to 10 % interval of the whole soluble pesticide concentration. These results are shed some light on new problems, which have not been investigated up to now. Explicitly, the small differences in the measured concentrations can cause ten times differences in the amount of pesticide in the soil. Even the tolerance of the soil capacity against disturbances can change by a magnitude in the mentioned interval.

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Coupled transport of humic acids and copper through saturated porous media

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The mobilisation of humic acid (HA)-metal complexes through the soil's pores is a key factor on the fate of contaminants in the environment. Due to its colloidal nature, transport of HA is controlled by the electrochemistry properties of the bulk soil solution (ionic strength, cation valence and pH). Suspensions of HA were added with (NO₃)₂Cu to obtain 100 mg L⁻¹ of HA, and copper concentrations ranging from 0 to 20 mg L⁻¹, for each Cu concentration aliquots were adjusted to pH 5, 6 and 7 respectively. All pH's in the suspensions were stable after 24 h. Suspensions were passed through quartz sand columns 100-mm length and 15-mm diameter. Breakthrough curves of HA, Cu-HA and free copper were obtained from their respective concentrations measured in the outflow using UV-photometry, AA-photometry and Cu-ISE, respectively. In free-Cu experiments the retention of HA in the column was higher when decreasing pH. Retention ranged from 16 % at pH 7 to 25 % at pH 5 of the amount of HA injected in the column. Retention of HA increased with the addition of Cu. Cu-ISE measurements in the outflow showed that binding of copper to HA was increased with pH. At high pH transport of Cu was coupled with of the HA, with low pH the transport occurred mostly as non-complexed Cu. Copper bound to HA was found to elute faster than free Cu. Breakthrough curves were modelled with the convective-diffusive equation to elucidate the influence of HA and the mechanisms involved in the transport of free and complexed Cu fractions. These results show the role of HA in facilitated transport of copper in porous media. The modelling transport on the basis of colloid-surface interactions allowed to understanding the facilitated transport in soils and it will let us predict the behaviour of metal in soils and prevent their negative impact in soil and groundwater environment.

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Polycyclic Aromatic Hydrocarbons in the atmospheric precipitation–soil–lysimetric waters system of technogenic landscapes

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The study of polycyclic aromatic hydrocarbons (PAHs) in soils is necessitated by the toxicity of these compounds and the widespread soil contamination with them. Soil is the main storage medium of PAHs in the landscapes. Soil properties determine the intensity of the accumulation, the migrational characteristics, and the possibility for conservation and subsequent mobilization of this group of organic compounds in the environment. This work is aimed at studying the quantitative and qualitative composition of polyarenes in the atmospheric precipitation–soil–lysimetric waters system, and estimating the degree of PAH influence on soils in technogenic landscapes.

Our studies revealed tendencies in PAH accumulation in the atmospheric precipitation–soil–lysimetric waters system of technogenic landscapes. The gas dust emissions of these enterprises contain significant amounts of polyaromatic hydrocarbons, which causes their elevated accumulation in atmospheric precipitation and their falling on the underlying surface, especially, in the sanitary-protection zones. The characteristic feature of atmospheric precipitation and lysimetric waters is the presence of low-molecular weight polyarenes: phenanthrene, anthracene, fluoranthene, pyrene, benz[a]anthracene, and chrysene, accounting for 93–96% PAH. Organogenic horizons of soil are capable of accumulating significant amounts of PAH from atmospheric precipitation in technogenic zones and polyarenes formed due to transformation of their “own” organic matter of soil. High migration ability is characteristic of most soluble low-molecular weight PAH throughout soil profile. The mass-balance calculations of PAH showed that their growth in soils is provided by phenanthrene, fluoranthene, and pyrene from atmospheric precipitations. The absence of high-molecular weight PAH (benzfluoranthenes, benz[a]pyrene, dibenz[a,h]anthracene, benz[ghi]perylene, and indeno[1,2,3-cd]pyrene) in the atmospheric precipitations and their identification in soil give ground to state that their accumulation was mainly caused by transformation of organic matter during pedogenesis. Aerotechnogenic impact on soils results in an increase of 3–4 nuclear PAH in their total balance, and the mass ratio of biogenic to technogenic PAH could serve as measure of technogenic impact on soils. The work was supported by the Russian Foundation for Basic Research (no. 07-04-00285-a, 11-04-00086-a).

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Effect of successive application of pulp mill sludge to degraded chilean volcanic soil: A columns leaching study

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Pulp mill sludge produced in Chile contains high organic matter content, microorganisms, macronutrients (phosphorus, nitrogen and potassium), microelements (Zn, Cu and Fe), and inorganic substances such as silt, clay and calcium carbonate. Currently, the use of pulp mill sludge to improve the nutrient contents of a soil is a common practice, but with the risk of soil and groundwater pollution.

The effect of successive application of pulp mill sludge to degraded chilean volcanic soil on groundwater pollution was studied through undisturbed soil columns. Columns were packed with soil (Andisol) that had received four applications of sludge in the range from 0 to 30 t ha⁻¹ during a year. Distilled water was added to each column simulating rainfall condition of 1200 mm per year and was maintained at room temperature. Periodically pH, electrical conductivity (E.C), COD, nitrate, Zn and Mn were analyzed.

The application of different doses of pulp mill sludge in the soil did not produce significant changes in the pH of the analyzed samples. The levels of conductivity increased when increased the dose of sludge, which was more evident after the last application. In general, the application of sludge increased COD's concentration and nitrate, due to the high level of organic matter and N of the pulp mill sludge. Successive application of pulp mill sludge dose did not produce significant changes in Zn levels of leachate. Manganese was not detected in the analyzed samples.

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Release and releasing kinetics of Cu in polluted soils treated with crushed mussel shell

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We study the Cu release in two soils with high Cu content: a vineyard soil with 361 mg kg⁻¹, and a mine soil with 589 mg kg⁻¹. Although having lesser Cu content, the release was higher in the vineyard soil, which has U shape Cu releasing curve. The release was 100 mg kg⁻¹ (and even higher in the acid side) for additions of 20 cmol(c) kg⁻¹ of acid or base. In the mine soil the Cu release was one order of magnitude lower in the acid side, while there was not significant release at basic pH's. Adding shell to the soils, a significant decrease was found for Cu release at acid pH's, while no significant effect was found at basic pH's. The stirred flow chamber experiments show different Cu desorption kinetic for shell amended and non-amended soils. For inflow solution with pH 3.5, the presence of shell reduced more than 80% the desorption rates in the mine soil, and 30% in the vineyard soil. For pH 5, the shell has not effect in vineyard soil, whereas in mine soil the Cu desorption rates were not detectable. For the acid/base treated samples, in the vineyard soil treated with HNO₃ 0.02M, the acetic acid extractable fraction increases as a function of the shell dose. However, in the no acid/base treated samples, as well as in the NaOH treated samples, this trend was not observed. In the mine soil the highest Cu fraction was the residual one, which increases with the shell dose.

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Changes in land use of contaminated sandy soils modify their trace metal availability

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At present there is tendency of changing the land use of contaminated agricultural soils towards non-food perennial crops like miscanthus. As the changes in land use bring modifications to soil organic matter quality and quantity, the trace metal bioavailability of the soils is susceptible to be modified. Our objective was to verify the hypothesis that the modification in trace metal availability occurs when annual crops system is replaced by a perennial crop system. We studied the soil metal availability using two approaches i.e. EDTA extraction to quantify the soil metal supply at equilibrium (24h) and kinetic extraction of metals to mimic dynamic process of bioavailability. Modelling of the kinetic extraction data allows quantification of soil metal supplies into two potentially bioavailable metal fractions in the soils i.e. labile metal fraction (immediately bioavailable) and less labile metal fractions. We sampled the sandy soils of a site polluted by input of untreated waste water over a century where the soils are cultivated with annual crops while a parcel is under cultivation of a perennial crop i.e. miscanthus since three years. We also sampled a non polluted soil under annual crop system belonging to the same site. At equilibrium results showed that the percentages of metal supplies for all studied metals were higher in the polluted soils than the control soil. Within the polluted soils there was no difference of Cu and Pb metal supplies between annual and perennial crop soils. But for Zn and Cd metal supplies of were higher under perennial crop soil than annual crop soil, suggesting an increase of total metal availability for these metals under miscanthus. Kinetics extraction results showed that the labile and less labile metal fractions were more in polluted soils as compared to control soil except for labile metal fraction of Pb and less labile metal fraction of Cd which were higher in control soil. Comparing annual and perennial crop polluted soils we found the similar ratios between labile and less labile metal fractions except for Zn for which the ratio was lower under miscanthus. As the total availability of Zn is higher under miscanthus, the decrease in its ratio between labile and less labile fractions suggests a change in Zn speciation. These results highlight that changing the land use of contaminated sandy soils can enhance the trace metal availability of metals with Zn being in our case the first indicator to show this modification

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Influence of Soil Characteristics on the Efficiency of Iron Nanoparticles for Lead Immobilization

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Soil contamination is one of the threats to soil functioning due to their persistence. The major anthropogenic sources of metals in the environment are mining and smelting, fossil fuel combustion, sewage sludge, industries, waste disposal, fertilizers, fungicides and other agricultural materials besides traffic and waste incineration. These activities lead to considerable soil contamination process. Heavy metals are well known to be toxic to most organisms when presented in high concentration in the environment. They can affect to the growth, morphology and metabolism of microorganisms in soils. However the total contents of heavy metals provide limited information on their mobility and bioavailability in soils.

Remediation strategies must be focused to minimize the risks due to the movement of the metals in the soil and the potential introduction in the food chain. In this sense, zero-valent metal iron nanoparticles are receiving great attention due to their potential application in the remediation of contaminated groundwater and soils.

In this study, the use of commercial zero-valent Fe-nanoparticles has been tested to immobilize lead in soils with different physic-chemical characteristics. Soils were artificially contaminated with Pb at the dose of 200 µg.ml⁻¹. After two weeks consolidation, Fe-nanoparticles were applied at 0.1 mg.g⁻¹ soil. Samples were homogenized and stirred for 72 hours. Then, different metal fractions were analysed, soluble, exchangeable, linked to carbonates and residual.

Experimental results indicate that after 72 h, more than 80 % Pb is immobilized in the alkaline soil (E) whereas the acidic soil (T), only retain around a 60% Pb. The immobilization process in the E soil is favored by the carbonate content, so the control soil itself immobilizes 62% Pb. The study of the metal in the different fractions shows an important increase of the residual fraction in both type of soils, although the nanoparticles dose is not enough to immobilize all the lead content in the soil. Soil characteristics play an important role in the efficiency of this remediation technology.

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Fate of emerging organic pollutants (Antibiotics) in soils. The role of metal complexation.

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The scientific community and the health authorities are increasingly worried about pharmaceuticals products "emerging" pollutants and their biological effects. The majority of scientific publications relate to the detection of emerging pollutants in sewage water as well as surface and groundwater. Much less studies are dedicated to the assessment of these pollutants in soils, despite the fact that soils trap these pollutants and simultaneously may control their further dissemination. The knowledge of the interactions of the Pharmaceutical Products with soil constituents appears thus of great importance with respect to both scientific interest and societal concern. The results of this work are the first fruit of a research programme that aimed at understanding the mechanisms controlling the retention, transfer and dispersion of emerging pollutants in models soil. The goal of these investigations is to elucidate the most important transfer and retention mechanisms as a function of soil composition. We intend to evaluate how a good understanding of the chemistry of the interactions of the test substances with dissolved material (major dissolved bivalents and organic material) and solids (mineral elements in the soil) can permit improving the prediction in a "operational" way their fate in different type of natural soil. This work specifically focuses on the antibiotic Sulfamethoxazole (SMX) used as a representative of antibiotic chemicals. SMX reactivity was in a well defined chemically aqueous environment of various pH and ionic strengths without any solid materials, particles or macromolecules. This compound has two amine groups that make it amphoteric with a switch in charge from neutral to negative. At first results we are going to show you will be the characterised physicochemical interactions using spectroscopy tools (UV, IR) in solution between different soil elements such as Cu, Zn and Al (elements considered as being involved in this molecule's retention and transfer processes) and SMX at different pH. We showed that interactions with such constituents involve the sulphonamide group of SMX, probably through complexation, in agreement with specifically pharmacists observation. Secondly, we will show you results in batch reactors. We investigated the adsorption of SMX in a loamy soil in order to study the effect of Cu, Ca with SMX present into the soil. Speciation calculation with PhreeqC permitted to explore the Cu, Ca, SMX interaction mechanisms.

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Assessing the disturbance of soils amended with high amounts of urban residues through testing the metabolic activities of microbial communities

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Nowadays, the use of sewage sludge or biosolids as amendments in soils has become relevant considering sustainable practices in agriculture. The use of these products obtained from different origins and containing big amounts of organic matter, contributes to the improvement of productivity of soils and to solve soil events in the Mediterranean region like erosion. Nevertheless, these residues are a problem by themselves, far from being solved, due to their increased production induced by the enhanced strictness of the regulations on urban wastewater depuration in UE.

Increasing the amount of residues used in soils could be a feasible solution although deeper studies are needed in order to avoid human and environmental health risks. Usually, the most sensitive biological factors are microbial populations which have been recognized as the essential living component of soil. Their size and activities can be seen as indicators of soil health or soil quality.

Most of the biological and biochemical changes in soils after amendment have been measured using either the activity of specific enzymes or the presence/absence/amount of biological markers. Only a few studies analyzed the effects on metabolic properties of the microbial populations in soil samples with methods like Biolog or Microresp (microbial community-level physiological profiles, CLPPs). In fact, the metabolic diversity of the soil microbial community has been suggested as a sensitive way to assess soil quality. For that purpose, we used Microresp method in order to analyze the effects of the amendment of a crop soil with 160 t ha⁻¹ of either biosolids, or aerobic or anaerobic sludge from urban origin under Mediterranean climate conditions.

Our results indicated that different amendments produced common and different modifications on the consumption of specific metabolites, being some of them specific of the type of amended residue and the season of the year. Microresp-CLPPs offered a convenient, rapid and sensitive method to detect the changes produced in these microbial communities after the application of agriculture amendments through testing the functional diversity and soil biomass in this kind of soils.

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Effect of organic amendment and vegetation of vineyard soils on copper distribution at the micro-aggregate scale

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In this study we evaluated the effect of organic management of vineyard soils on the distribution of copper at the micro-aggregate scale of soils. The model vineyard soil used in this study (Macon, Burgundy, France) experienced a field experiment over twenty years that consisted in amendments and vegetations with various materials and plants. We studied specifically the effect of straw (S) and conifer compost (CC) organic amendments and clover (Cl) and fescue (F) vegetation on the fate of copper, used as fungicide, in the surface layer of this loamy soil (non amended, NA, control soil). These five soils were collected in June 2009 and immediately physically fractionated in order to obtain 5 granulometric sub-fractions, supposed to represent specific habitats for soil microorganisms as well as variable copper-reactive compartments. All soil fractions were quantitatively characterized in terms of contents of solid mass, total nitrogen and organic carbon (TOC), major elements and of copper content (total, Ca-exchangeable, free and bioavailable to bacteria and plants). The results permitted to show that each soil fraction presents a specific inorganic and organic composition. Indeed, whatever the treatment, amendment or vegetation, major elements and TOC distribution are highly variable in the soil sub-fractions and between soils. Both soil treatments induced TOC increases, the highest increases being observed for the Cl and CC soils (x1.8 and x2.8, respectively). Organic carbon accumulated preferentially in the 20-2 μ m fraction of the five soils (ranging from 6.3 to 10.3 mgC.g⁻¹ of soil) and also in the coarser fraction (>250 μ m) where freshly added carbon accumulates before being progressively degraded. Copper distribution was shown to be different between the five soils. The amended soils accumulated more copper in the coarser fractions, especially the CC soil, probably in relation with the reactivity increase of this fraction that is enriched in freshly added organic carbon. The vegetated soils, and especially the Cl soil, accumulated much more Cu in the finest and micro-aggregated (20-2 μ m) subfractions, probably in relation with the increased rhizospheric development well known to increase soil aggregation. These differential accumulations were shown to modify copper bioavailability to plants and soil bacteria. Our results showed that soil organic management clearly modifies copper bioavailability and probably toxicity to living soil organisms in the field

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Hedges of vetiver grass (*Vetiveria zizanioides*) for remediation of vertisol and lixisol.

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Solid wastes applied on vegetable crops in Burkina Faso lead to soil contamination by heavy metals responsible of plants and drinking water contamination. Hedges of vetiver grass (*Vetiveria zizanioides*) were proposed in order to limit the transfer of pollutants towards waters. This work aims to study the fate of copper and cadmium in soil-vetiver system. Cu and Cd adsorption isotherms were characterized from planted and unplanted vertisol and lixisol. Thereafter, the uptake and the translocation of Cu and Cd by vetiver grass were investigated at two concentrations (100 mg kg⁻¹ Cu + 2 mg Cd kg⁻¹ and 500 mg kg⁻¹ Cu + 10 mg Cd kg⁻¹) in a pot experiment under laboratory conditions. For each soil, pots planted or not (control) with vetiver and, treated or not (blank) with Cu + Cd were monitored during 6 months.

For both soils, adsorption coefficient values (K_f) were highest in planted soils compared with unplanted controls, in relation with a slightly higher organic carbon content of planted than that of control soils. In addition, vertisol adsorbed larger Cu and Cd amounts than lixisol, probably due to their highest organic carbon and clay contents.

Six months after treatment, for both soils, vetiver shoot and root biomass decreased significantly with the greatest Cu and Cd concentrations compared with blank. The MgCl₂ exchangeable Cu and Cd contents were lowest in planted than in control soils for both Cu and Cd concentrations, related to the higher Cu and Cd adsorption on planted soils. In vetiver grass, Cu and Cd contents were greater for lixisol (Cu = 418 - 5863 mg kg⁻¹ and Cd = 19 - 197 mg kg⁻¹) than for vertisol (Cu = 218 - 1534 mg kg⁻¹ and Cd = 4 - 65 mg kg⁻¹), in agreement with the largest MgCl₂ exchangeable Cu and Cd amounts in lixisol compared to vertisol. Then, Cu and Cd accumulation expressed by the metal biological absorption coefficient (BAC, plant-to-soil metal concentration ratio) and the bioconcentration factor (BCF, root-to-soil metal concentration ratio) were greater than 1 for both soils. Translocation factor (TF, shoot-to-root metal concentration ratio) appeared to be less than 1 and greater than 1 for lowest and highest Cu-Cd treatments, respectively.

These results showed the efficiency of vetiver in the Cu and Cd uptake, which also seems to concentrate Cr and Ni, but investigations were needed at field scale.

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Amelioration of aluminium toxicity by calcium sulfate in Highbush Blueberry (*Vaccinium corymbosum* L.)

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Highbush blueberry (*Vaccinium corymbosum* L.) has been developed in acid soils ($\text{pH} \leq 5.5$), but in Andisols it is sensitive to phytotoxic aluminum (Al^{3+}). It is known that the aluminium toxicity causes a reduction in growth, and an increase in oxidative stress. Currently, calcium sulfate (CaSO_4) is an agricultural practice used to ameliorate this toxicity, mainly due to it practically not change the soil acidity reducing the Al-phytotoxicity. However, little is known about the effects of CaSO_4 on the physiological and biochemical parameters in this species.

In this work the CaSO_4 effects on physiological performance in highbush blueberry cultivars (Legacy, Brigitta and Bluegold), grown in Hoagland solution subjected to phytotoxic Al was studied using following treatments: Control, 2.5mM CaSO_4 , 100 μM Al as AlCl_3 and 2.5mM CaSO_4 + 100 μM Al for 15 days under greenhouse conditions. Thereafter, Al content, mean relative growth rate (MRGR), photosynthesis and superoxide dismutase activity (SOD) were evaluated in leaves. In Al treatment, Legacy and Bluegold cultivars increased significantly (four-fold) their leaf aluminium (Al) content, decreasing with CaSO_4 ($P < 0.05$). Mean relative growth rate (MRGR) was significantly affected by Al toxicity in Brigitta and Bluegold ($P \leq 0.05$), whereas in Legacy it was not affected. Interestingly, the MRGR was recovered only in Bluegold by CaSO_4 . Photosynthesis was significantly diminished (50%) in Bluegold cultivar ($P \leq 0.05$), increasing slightly with CaSO_4 . Superoxide dismutase activity (SOD) augmented significantly and steadily with treatments in Legacy. In Bluegold, this augment was remarkable under CaSO_4 ($P \leq 0.05$). It is concluded that CaSO_4 treatment can help to decrease the oxidative stress produced by Al toxicity in Bluegold cultivar (Al-sensitive), improving its growth. Nevertheless, Legacy the most Al-tolerant cultivar did not affected for CaSO_4 treatment.

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Application of stabilized Fe⁰ nanoparticles for remediation of Cr(VI)-spiked soil

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In this study, laboratory batch experiments were conducted on a Cr-spiked soil to evaluate the effectiveness of synthesized starch-stabilized Fe⁰ nanoparticles, compared to Fe⁰ and Fe₃O₄ with different particle sizes, for decreasing water-extractable Cr(VI). Comparative studies carried out in a Cr(VI) concentration of 100 mg kg⁻¹ and Fe materials dosage of 1.5% w/w. Results indicated that stabilized Fe⁰ nanoparticles pose a higher efficiency (100%) to immobilize Cr(VI). Several factors affecting the immobilization of Cr(VI) using stabilized Fe⁰ nanoparticles including reaction time, initial Cr(VI) concentration in soil, Fe⁰ nanoparticles dosage, and pH were investigated. Cr(VI) immobilization percentages decreased from 100% to 54% as the initial Cr(VI) concentration increased from 50 mg kg⁻¹ to 1650 mg kg⁻¹. Furthermore, increasing Fe⁰ nanoparticles dosage from 0.5 to 3% w/w caused 70% increase in the immobilization efficiency. The results indicated that rising of soil suspension pH from 5 to 9, in both buffered and unbuffered conditions, does not have any significant effect on the extent of water-extractable Cr(VI)

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Organic matter characterization and their mercury content in soils at the mining region of San Joaquin, Queretaro, Mexico

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Organic matter (OM) is fundamental for the buffering soil functions offered into terrestrial systems. As their main constituents humic substances (HS) could bind potentially toxic elements such as mercury (Hg), according to their quality and complexity. Mercury dynamic in soils is conditioned by biological processes, as well as by their physical and chemical soil properties, in which HS perform a fundamental role. Colloidal character of these substances, allow their interaction with several cations, favoring or restricting their mobilization through soils. HS form stable compounds with Hg that reduce their mobility and availability for other systems. Because of the complex of this issue, few studies have examined the OM role into retention and/or emission of mercury into the atmosphere, thus turning soils into a source of emissions as well favouring chemical changes for Hg. The main objectives of this work have been to determine total mercury (THg) content and the proportion of Hg linked to humic substances in soils of San Joaquín, Qro. Soil properties were measured according to ISRIC (2003) in sites close to cinnabar mines with forest vegetation (*Quercus* spp.) and with crops, mainly corn. Organic matter fractions were obtained according to Dabin (1971) and the International Humic Substances Society methods (IHSS, 2009); isolating light organic matter (LOM), fulvic acid (FAH3PO4), fulvic and humic acids (FA and HA) and humin (HU) fractions. THg content was determined for each fraction by microwave digestion and measured with hydride generation by atomic absorption spectrophotometry. The results were analyzed by statistical treatments mainly non-linear and factorial discriminant analysis. Soils show a slightly acidic to neutral reaction (6.50 to 6.88 in the forest and agriculture use), with silty-clay texture. The organic carbon content in forest soil was 26.6 g.kg⁻¹ and 11.8 g.kg⁻¹ in crop soil. Humic substances in forest soil retained 53.78% of total Hg, while the crop soil retained 60.27%. However, within the fractions constituting the HS, mercury retained a larger proportion in less stable fractions (LOM and fulvic acids) in both soils. The above means that these soils might be potential pools of Hg emissions from these fractions. Meanwhile, in the more stable fractions, such as HA and HU only 2.57% and 1.96% of Hg was retained in forest and crop soils respectively.

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Copper in a Vineyard Soil Variably Amended with Organic Matter: Organic Matter, Cu Distribution and Speciation Relationships

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Copper is widely used as fungicide in vineyard cultures, its use potentially affects the soil copper speciation, the soil bacterial communities and the there from dependent structures and functionalities of the soil organic matter. In the frame of an interdisciplinary research program, these parameters and their evolution were investigated during a two years incubation experiment on vineyard soils differently amended with organic matter, and contaminated or not with copper. Different investigation tools and methods such as synchrotron-based μ SXRF and μ EXAFS, GC-MS, titrimetry, and fractionation methods (soft granulometric fractionation and flotation) were applied. The copper was shown to penetrate the whole soil matrix, binding weakly but majoritarily to the predominant clays, and minoritarily but strongly to the organic matter. EXAFS results indicate that Cu binds through formation of malate-type chelates. Chemical analysis show that particular organic of soils have highest copper concentrations (seven times the mean value). The time survey shows that in soils amended with organic-matter, the organic-rich coarse fractions, and especially organic particles degrade more rapidly. The degradation of of the organic matter are accelerated in copper contaminated soils. The fact that this process is especially observed in the organic-rich soils suggests that the present copper stimulates the carbon mineralization. This unexpected result is confirmed from the time survey of the relative abundances of alkanols, alkanolic acids and sterols, as obtained from GC-MS lipid extraction experiments: 1-alkanols and alkanolic acids are found to decrease, i.e. degrade, more rapidly in copper contaminated soils. Wet chemical experiments show that soil pH, exchanged Ca⁺⁺ and aqueous Cu⁺⁺ concentrations vary strongly between the granulometric fractions, the whole-soil mean values appear to be a poor representation of the values measured on smaller scales. The measured parameters, and especially the aqueous and a priori toxic copper thus varies significantly dependent on both, soil compartment and time.

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Degradation of the pesticide MCPA in the detritusphere – A new mathematical model

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The detritusphere is characterized by high availability of litter derived organic substrates stimulating microbial growth as well as metabolism and co-metabolisms of recalcitrant compounds. Based on an existing carbon model we developed a new model, which accounts for transport and degradation of pesticides and which includes the pool size of total and specific soil microbial communities in the detritusphere. Fungal MCPA degradation was modelled by a co-metabolic kinetic. The model simulates ¹²C, ¹³C and ¹⁴C carbon pools explicitly. Linked with an appropriate experimental design this feature enables us to trace the carbon flow between the different pools in the detritusphere. A global sensitivity analysis was performed to identify the high-leverage model parameters. For model calibration, we conducted a microcosm experiment with ¹⁴C MCPA (50 mg kg⁻¹) amended soil. We set up three experimental treatments: i) maize litter (control), ii) MCPA and iii) MCPA + maize litter. The litter was placed on top of small disturbed soil cores and the microcosms were incubated at 20 °C for 20 days. During incubation we analysed total CO₂, ¹³C-CO₂ and ¹⁴C-CO₂. Soil cores were sampled on five dates using a stratified sampling scheme and analysed for MCPA, dissolved organic carbon (DOC), microbial biomass, 16s rDNA and the functional gene *tfdA* as a proxy for the population of bacterial MCPA degraders. The isotopic composition (¹³C, ¹⁴C) was measured of DOC, microbial biomass and total carbon in soil. We will present the new model and discuss simulations and parameter sensitivities against the background of the data from the microcosm experiment.

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Drug-resistant microorganisms in soils fertilized with sewage sludge.

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Waste treatment is always accompanied by generation of sewage sludge. One of the methods of disposal of sewage sludge, which is based on their fertilizing properties, is their use in nature, e.g. in farming (if all the permissible standards are met). However, the sludge used for soil fertilization might also contain heavy metals, pathogenic microorganisms, thus causing contamination in soil foundation and deterioration of the conditions for development of indigenous organisms. Particular threat is posed by existence of drug-resistant microorganisms. This problem has not been researched in detail yet.

The aim of the investigations discussed in the present study was to determine qualitative and quantitative changes in drug-resistant microorganisms in sandy soil fertilized with selected sewage sludge and manure. The investigations were carried out under conditions of pot experiment. The following doses of organic fertilizers were used: 0, 10, 50, 100 and 200 Mg/ha (maximal reclamation dose). Sewage sludge after different types of drying process was added to the degraded sandy soil. The effect of the methods of sewage sludge drying on concentration of drug-resistant microorganisms in soil fertilized with the sludge. Drug-resistant bacteria count after use of sludge and manure was also compared. The investigations were carried out within the timeframe of three years.

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Metals in soils amended with biosolids

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In the municipality of Puebla, Mexico, the biosolids produced in the water treatment plants are being used in agricultural soils to improve its productivity. Nevertheless, without the adequate management conditions this biosolids use would cause problems of both soil and ecosystem contamination. Therefore the purpose of this work was to determine the total content and availability of Pb, Cd, Cr, Ni, Cu, Zn, and Mn in soils treated with biosolids compared with similar soils that are not receiving these materials. Metals in soils were extracted, at three soil depths, with HNO₃ 4 N to determine its total metal content, and with DTPA to determine its available metal content. Also was determined the relative availability of each metal.

Higher contents of Cu, Ni, Pb, Zn and Mn were found in top soils superficial horizons which is due to the addition of biosolids, nevertheless the values of available metals matched in the range of normal values for agricultural soils. Cd present value normal The contents of the all metals, in the subsuperficial horizons present a significant differed from, those in the top horizon, according to the analysis of variance realized ($p = 0.05$).

The relative availability was calculated in an interval between 20 to 35% for the metals determined, in both plots types, which indicates that the properties of these soils does not favor an increase in the metal availability after the biosolid additions The availability order of the metals by means of the ratio available metal / total metal changed for some metals. In the soils with biosolids the increasing order of relative availability was higher contents of Cu, Ni, Pb, and Mn were found in surface soil horizons which is due to the addition of biosolids, nevertheless the values of available metals ranged within the frequent background values for agricultural soils with exception of Pb, that is over the maximum permissible value.

The results show that the application of biosolids is increasing the metal content with the exception of Cd, in soil superficial horizons, however the relative availability of metals in these soils have not been strongly affected because of biosolids application.

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Session 4

Soil microbial activity and soil function

Soil properties of Mediterranean agricultural areas under fast-growing Paulownia (*Paulownia elongata* x *fortunei*) plantations

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The aim of this work was to evaluate the effects of paulownia plantation on the chemical, physical and microbiological properties of a soil in Mediterranean agricultural areas. An Aleppo pine (*Pinus halepensis* L.) forestation, a maize (*Zea mays* L.) crop and a soil without human interference were also selected in the same area in order to compare results obtained. Paulownia plantation and maize crop showed higher values of organic matter content, total N, total organic carbon and heavy metals (Cu, Cr, Pb, Ni and Zn). However, Aleppo pine forestation and control plot presented higher enzymatic activities (phosphatase, β -glucosidase and dehydrogenase) and soil respiration than agricultural uses or paulownia plantation. The ploughing operations with the consequent increased aeration, fertilization and cropping practices, as well as the vegetation management and composition influence microbial populations and enzyme activity, generating a lower soil quality in managed soils. Paulownia plantation should avoid the use of machinery and fertilization, which incorporate heavy metals into the soil or increases soil aeration, reducing the soil respiration and enzymatic activity levels. Moreover, enzymes and soil respiration might be useful as early indicators of biological changes.

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Mangrove soil of the Graciosa River, in Bahia, Brazil: the microbial approaches

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Mangrove soils are predominantly halomorphic with high organic matter content, developed from marine and riverine sediments and occur in tropical and subtropical coastal regions of flat topography and under constant influence of the sea. These soils have physical, chemical and microbiological particular properties, running to transform, remobilize and fix several chemical compounds of biogeochemical and ecological importance. This study aimed to highlight microbiological data of the mangrove soil in south Bahia, Brazil. Samples were collected of the soil profile from a deforested, disturbed site and from an adjacent undisturbed site. Microorganisms were more concentrated into the superficial layer of the undisturbed site, and the data suggest that microbial populations may be favored in the soil layers most affected by high and low tides, C1 (0-20 cm) and C5 (99-125 cm).

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Soil humidity, soil depth and density of plantation influence catabolic structure of microbial communities in maize crop system

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Microbial activity in soils plays a critical role in decomposition of organic matter and in immobilization and mineralization of nutrients, which are important processes for the regulation of plant growth and productivity of agricultural systems. Inversely, plant community structure and density can drive edaphic microbial communities. In the context of global change, Mediterranean-type ecosystems surface soils undergo prolonged periods of drying interspersed with rapid rewetting events. These events can affect directly and indirectly (via soil water and substrate availability) plant production and microbe activities. We tested the hypothesis that in context of drought stress, different geometry and density of plantation may influence catabolic structure of microbial communities in maize crop system.

A field experiment was conducted to examine microbial catabolic structure in two soil depths (2 and 20cm) under three different conditions of drought stressed maize plantation (two densities of plantation). Measurements of substrate-induced respiration (MicroRespTM) were realized before and after the autumn rain events. Water soil content was measured in situ with Electrical Resistivity Tomography and maize biomass was measured at the end of crop. The microbial biomass and catabolic structure distinctly changed with depth, probably related to the soil moisture dynamic conditions and to the quantity and quality of total organic carbon. At 20cm depth, plantation density seems to influence catabolic structure; lower density plantation is characterized by the catabolism of amino acids and phenols, whereas the higher density plantations are characterized by the catabolism of carbohydrates. Catabolism structure changes before and after the rain for the higher density plantations but not for the lower one. Finally the repartition between vegetative and reproductive maize biomass was different between the two densities of plantation. These results suggest that interactions between microbes and plants via microbial carbon degradation and root exudates are dependent upon environmental conditions like water availability.

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Response of soil microbial biomass to CeO₂ nanoparticles

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The aim of this work was to assess the impact of the chronic exposure of CeO₂ nanoparticles (NPs) (50 to 105 nm nominal size) on soil microbial biomass.

To evaluate if the CeO₂ NPs can affect the soil quality, they were mixed to an A1 horizon of Epileptic Cambisols at a concentrations of 100, 500 ppm and incubated in lab for short and medium (7 and 60 days) times, at a constant temperature (25°C) and moisture (60% WHC).

The preliminary results of the soil physicochemical analyses have showed an insolubility of the CeO₂ NPs at short-term incubation in water, EDTA and aqua regia. The biological assays detect a storing of Ce-CeO₂ (0,31 to 49 µg/kg ds) in the microbial biomass at short time that decreases about 25% in the C amount. An increment of the basal respiration and a decrease in the amount of carbon soil microbial biomass determined a higher metabolic quotient (qCO₂) than the control test, that identifies a stressful situation, most evident in the short term condition.

Physical-chemical characterization of the CeO₂ NPs and of the soil before and after the NPs addition, was carried out by means of Environmental Scanning Electron Microscope (ESEM) and an Energy Dispersive Spectroscopy –(EDS) . The investigations showed Ce-NPs and Ce-compounds in both-incubation-condition samples. The control soil showed the presence of cerium associated with other elements, like P, Nd, La, Th e Si. From literature, it appears that these elements identify Monazite-Ce/Nb minerals, whose chemical formulas are respectively (Ce, La, Nd, Th) PO₄ and (Nd, Ce, La) (P, Si) O₄. The presence of CeO₂ NPs was clearly detected in soil and recognized by ESEM morphological observations coupled with EDS characterization. The NPs chemical composition appears unaltered, while the size can be modified by NPs aggregation and clustering.

The results contribute to setting reference baseline values of cerium in soil and indicate an impact on the amount of carbon soil microbial biomass due to a higher metabolic quotient (qCO₂) that can condition the soil fertility.

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Molecular characterization of hydrophobic coatings and fixed lipids from extremely water repellent pine and eucalypt forest soils.

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Lipid fractions from 16 forest soils characterized by extreme water repellency (WR) and developed from different materials (granite, schist) and vegetation (pine, eucalypt) were analyzed by sequential extractions followed by gas chromatography-mass spectrometry in order to discuss its molecular composition in terms of severity and persistence of WR. Lipid speciation was studied by successive extractions (free lipid directly removed with petroleum ether, presumably occurring in external surfaces of soil aggregates, hydrophobic coatings, and 'fixed lipid' obtained with the same solvent after 2M H₃PO₄ treatment of the soil, probably including covalently bonded lipids in addition to lipids tightly bonded to the mineral matrix).

Major compounds in free lipid fractions were diterpene resin acids (dehydroabietic and pimaric acids) in pine forest (up to 20% total lipid) with phenol and globulol as major compounds in soils under schists. Alkanes and fatty acids accounted for more than half of the total lipid, being the major compounds in soils under schists. The fatty acid series showed uni- or bimodal distribution with (maxima ca. C16 and C24–26) and high even-to-odd C number preference.

Major compounds in the 'fixed lipid' were n-alkanes and n-fatty acids, the former amounting for ca. 90% in soils under granite whereas the latter may represent ca. 50% in soils under eucalypt. In the case of 'fixed' fatty acids, the even-to-odd C-number preference remained high, and the chain length was lower than in free lipids, with C16 and C18 as major compounds.

After removing free lipids, soil WR decreased but remains extreme (water drop penetration time between 1–3 h). Further extraction of 'fixed lipids', led to drastic soil WR decrease, but total disappearance of WR required complete removal of macromolecular humic fractions. When analyzing the effect of lipid fractions on WR, it was clear the dominant role of vegetation as regards the effect of free lipid, whereas for 'fixed' lipid, WR depend mainly on the parent material.

The lipid compounds more correlated with WR were monoterpenes (in pine forest) or sesquiterpenes (in eucalypt forest) as well as oxygenated terpenes. In both cases persistent WR was correlated with the concentration of n-alkanes and with chemical characteristics of soil organo-mineral complexes, i.e., not mainly depending on hydrophobic coatings but probably on hydrophobic cements tightly incorporated in the humus-clay matrix.

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Microbial communities in vineyard soils with changing land use: effect of Cu accumulation and soil pH.

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Due the use of agricultural land for grape production, with frequent use of Cu-based fungicides, Cu concentration has been increasing in these soils in many parts of the world. Moreover, in vineyards with acid parent materials it is very common to use lime in order to increase the soil pH and improve crop yields. Thus, vineyard soils in areas with acid rocks as parent materials have a large variation in pH and Cu concentrations. These circumstances can promote alterations in soil microbial communities, making it difficult to isolate possible toxic Cu effects on the soil microbes. Here, analyses of phospholipid fatty acid (PLFA) patterns and pollution-induced community tolerance (PICT using leucine incorporation) were used to study the effect of Cu accumulation and soil pH on soil microbial communities in vineyards with different land use history (young, old, and abandoned). The PLFA analysis did not show significant differences between different land uses. Instead, the results suggested that soil pH played a dominant role in determining the composition of microbial community the soils. However, an effect of the Cu concentration could be detected but its effect on microbial community composition was less important than pH. PICT analysis suggested that bacterial communities in old vineyards were more tolerant to Cu than in the abandoned vineyards. However, increased PICT (Cu tolerance of the bacterial community) was not directly correlated with Cu concentration in the soils. Instead the estimated Cu tolerance was significantly correlated with soil pH.

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Nodulation and growth of common bean (*Phaseolus vulgaris*) in multi-local field tests of organic horticulture in Hérault valley links with phosphorus bio-availability.

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As a major contributor to the reduced nitrogen pool in the biosphere, symbiotic nitrogen fixation by legumes play a critical role in a sustainable production system. However this legume contribution varies with the physico-chemical and biological conditions of the nodulated-root rhizosphere, especially phosphorus that is one of the most limiting soil nutrient for plant growth. It is estimated that P availability to plant roots is limited in two thirds of the cultivated soil in the planet. Most of the P applied to soil can be converted into unavailable forms that cannot be easily utilized by plants. To improve growth under P-deficient conditions, P-efficient plants have evolved two major strategies: (i) external by increasing P acquisition through root morphology, root exudation, mycorrhization and P uptake mechanisms, and (ii) internal by enhancing P utilization at the cellular level and the distribution of P among plant organs. In this work multilocation tests were carried out in various fields of organic horticulture in the Herault valley (France). In order to assess whether the nodulation, and subsequent growth of common bean, were limited by P bio-availability, the shoot and nodules dry weight, number of nodules, P contents of nodule and shoot, soil total and Olsen P, calcium carbonate and soil pH were measured for cultivar Pongo in various sites among farmer's fields through three seasons in 2006-2009. A large variation in nodulation was observed between years and locations, including within some locations during some years. In many sites, nodulation was found to be inhibited by an excess of N mineralization from organic fertilization. Among other sites a positive correlation was generally observed between nodule biomass and shoot growth at flowering stage whenever the mean nodule mass per plant was above 46 mg DW pl⁻¹. The measurement of Olsen P in the soil surrounding the nodulated-roots show that the increase in nodule biomass per plant was associated with an increase in bio-available P. It is concluded that the symbiotic nitrogen fixation by legumes could contribute to the P bio-availability in low-P soils, and that various tools and indicators are available for developing the ecological engineering of the rhizobial symbiosis, in particular for its beneficial contribution to the bio-geochemical cycle of N, and also P.

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Changes in the Microbial Community of a Semiarid Degraded Soil after the Addition High Amounts of Organic Urban Wastes

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The increasingly production of urban wastes is a problem that requires an immediate solution. Another problem is the high level of degradation exhibited by the soils of extended areas of SE Europe. Despite the fact that the scarcity of organic carbon is a common factor in these areas, little is known about the maximum amount of organic amendments that can be used, without risk for soil ecosystem, for recovering degraded soils in semiarid environments. The objective of this work was to establish the potential risks for soil microbial populations associated with high-dose applications of this type of waste, assessing the impact of the amount and level of stabilization of the organic matter incorporated to the soil on the growth, activity and functional and structural diversity of the soil microbial community. To this, a degraded soil from SE Spain was amended at rates of 150 (d1) and 450 t/ha (d2), with a mixture of municipal solid waste and sludge at three different levels of stability (fresh material, FR, and composted for 30, FC, and 60 days, MC) and submitted to an incubation period of nine months under controlled conditions. Parameters indicating the size and general metabolic activity of microbial community were determined along the incubation period as well as labile C fractions and specific activities related to N, P and C cycles in the soil. In addition, the structure of the microbial community and its affinity for different carbonaceous substrates were evaluated by phospholipid fatty acids (PLFAs) and BIOLOG Ecoplate analysis, respectively. A strong organic matter mineralization was observed in all amended soils during the first three months of incubation. Initially all amended soils showed a sharp decline in enzyme activity, this decrease being greater for d2. However, at the end of the experiment, all amended soils showed higher enzyme activity values than the unamended soil. On the other hand, the analysis of PLFAs and BIOLOG reflected changes in the structure and functional diversity of soil microbial community, these change being more noticeable for d2 treatments, especially in the treatment MC. From results, it can be concluded that the addition of urban wastes to an arid soil improves the size and activity of a degraded arid soil increasing at the same time soil microbial diversity. No risks for soil microbial community are derived from the application of high rates of urban wastes for the recovery of degraded arid soils.

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Microbial biomass activity in neotropical savanna soils managed during six years with conservationist cereal-cattle systems

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In well-drained savanna ecosystems the edaphic conditions; acidity and gross textures, joined to the strong climatic seasonality, produce one of the principal problems for the vegetal production; the P and N deficiency. So, the microbial biomass activity could be oriented to the mineralization or immobilization of important elements in the soil, using the organic residues with distinct C/N ratios combined with fertilizers that promote different P availabilities for the crops. The objective of this study was to evaluate these microbial activity changes in agroecosystems of maize cultivated under no-tillage, established in well-drained savanna ecosystems. The perennial cover crops; *Brachiaria dictioneura* (BD) and *Centrosema macrocarpum* (CM) were introduced in 2002. Two years later, they were associated with maize cultivated under no-tillage and different phosphorus sources: phosphoric rock (RF), diammonium phosphate (IR), native mycorrhizas used as maize's inoculums (FB) and the phosphorus produced by the organic residues mineralization of the cover crops (Io). Every year until 2008, once the maize was harvested, four animals (cows) per treatment (cover and fertilization) were introduced for grazing. The experimental layout was big plots without repetition where a previous geostatistic study of spatial variability was made. Twelve soil samples were collected randomly (0-5 cm depth) at each sampling plot and at three different stages of the agro-ecosystem: i) before cutting the covers (AC) (dry-rainy season transition), ii) at the flowering peak of maize (F), (rainy season), iii) after grazing (dry season). Microbial biomass carbon (CBM) and nitrogen (NBM), basal respiration (CO₂) and metabolic quotient were estimated. Temporal variations of the microbial activity were found, showing a significant increase ($P < 0.05$) with the cover crops introduction. Their dynamic patterns during six years of the essay also were different ($P < 0.05$), depending of the phosphorus source-cover crop interaction. It was found that RF and IR promoted a higher CMB when they were used with the legume cover crop associated to maize (CM). RF and FB induced a higher mineralization activity at beginning of maize development, just when there is a major demand. The CO₂ dynamic showed fewer differences between cover crop treatments during the essay evolution. It was evidenced that RF could promote minor efficient of the microorganisms in BD than CM, where there was minor constrains by N.

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Calcified roots argue for the heterotrophic lifestyle of branched tetraether source bacteria

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Branched glycerol dialkyl glycerol tetraethers (GDGTs) are complex lipids of high molecular weight, suggested to be produced by as yet unknown bacteria in soil and occurring ubiquitously in terrestrial and aquatic environments. The analysis of a large set of soils revealed that the composition of branched GDGTs was mainly related to air temperature and soil pH. Over the last years, an increasing number of studies focused on the potential use of branched GDGTs as paleoclimate proxies. However, little is known about the lifestyle of the microorganisms synthesizing these compounds. The aim of the present work was to examine the distribution and abundance of GDGTs in rhizoliths (calcified roots) and surrounding sediment collected from a loess-palaeosol sequence in Nussloch (SW Germany).

For two rhizoliths from a depth between 2.2 m and 2.6 m below present surface, loess transects were sampled from the former root towards root-free loess at distances of 0-2.5 cm and 2.5-5 cm (rhizoloess samples). Two reference loess samples without visible root remains were taken at a distance of 50-70 cm from the rhizoliths.

Branched GDGTs were much more abundant in the rhizoliths than in the rhizoloess and almost absent in reference loess samples. The very high abundance of branched GDGTs in the rhizoliths suggests that branched GDGT source organisms fed on root remains. In larger distances to root surfaces, nutrient and energy supply decreases, likely leading to the lower abundance of branched GDGT source microorganisms observed in the rhizoloess and reference loess compared to the rhizoliths. Branched GDGT distribution patterns were different for individual sample types. Branched GDGTs in the rhizoliths and loess might have been produced during different time intervals, since radiocarbon dating of one rhizolith revealed its Holocene age (3150 years b.p.), in contrast to late Pleistocene age of surrounding loess (17-20 ka). In rhizoliths, branched GDGTs were very likely generated during and/or after plant death, whereas in loess they were probably formed after sedimentation and/or during earlier pedogenesis of the modern soil. Consequently, the age of branched GDGTs in the rhizoliths and reference loess may differ, which could explain the differences in GDGT composition between the former roots and the loess. To the best of our knowledge, this is the first time that the heterotrophic lifestyle of branched GDGT source bacteria is evidenced solely based on GDGT abundance.

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Effect of cropping systems, mineral nitrogen (N) and crop residue on total soil microbial community under soybean in Meru south (Chuka) central highlands in Kenya

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In Kenya soybean is grown under different soil management systems. Scarce information is found on the effect of cropping systems, N and crop residue application on the diversity of total soil microbial communities. The objective of this study was to evaluate the response of total soil microbial communities to different soybean cropping systems, N and crop residue incorporation. Four cropping systems each per main plot were compared; mono-legume (ML), mono-cereal (MC), association (AS) and rotation (RO). N and crop residue were randomly applied in a split pattern. Soil samples were collected at (0-10 cm) depth from each sub-plot after three years and at time zero for comparison. Soil microbial DNA was analyzed using Polymerase Chain Reaction–Denaturing Gradient Gel Electrophoresis method based on 16S/18S rDNA to assess the composition of both bacterial and fungal communities.

After 3 years, diversity of total bacterial communities after cropping was significantly lower compared to diversity at time zero. AS plots had significantly lower diversity of total bacterial communities compared to the other cropping systems. Crop residue applications had no significant effect on diversity of total bacterial communities. On the other hand, plots having received crop residues had significantly higher diversity of total fungal communities compared to those which did not receive crop residues. Additionally, diversity of total fungal communities was significantly lower under MC and ML systems compared to RO system at ($P < 0.05$), and compared to AS system at ($P < 0.001$). MC and ML plots were significantly different in fungal communities' diversity at ($P < 0.001$). Higher diversity of total bacterial communities than total fungal communities was observed both at time zero and after cropping. We noticed the absence of significant differences in diversity due to N application on both total bacterial and fungal communities. This could be because amounts of total N (%) and total C (%) were moderate at time zero (0.22 and 2.39) respectively. Addition of mineral N to these soils may therefore not influence total diversity of microbial communities. This study was useful to get a better understanding on the impact of factors such as cropping systems, crop residue applications and N fertilization on total microbial diversity. The next step would be to investigate functional activities linked up with N cycle such as nitrification by using specific primers or quantitative PCR.

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Phosphate fertilizers and cereal/legume rotation improve crop yield and total microbial community diversity in soil of Western Kenya

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Cereal- legume rotation has been promoted as a strategy to increase crop yields in subsistence farms of sub Saharan Africa, and is believed to promote changes in the rhizosphere that enhance early plant growth. This study investigates the effect of cereal-legume rotation (maize (Mz) – soybean (SB); common bean (CB)-SB-Mz; SB-Mz) in combination with different rates and types of phosphate (P) fertilizers: Minjingu phosphate rock (MPR) and Triple super phosphate (TSP) on crop yields and total microbial diversity in a Kenyan Ferralsol. Soil sampling for analysis of microbial diversity was done in the third season of rotation, at three weeks after crop emergence. The microbial communities from the rhizospheric soil were generated using denaturing gradient gel electrophoresis (DGGE). Shannon Weaver index of diversity was used to determine the microbial diversity. Results showed significant increases in crop yields with a significant interaction ($P \leq 0.05$) between fertil

izer addition and rotation regime during the three seasons. The highest maize yields were realized following a CB-SB-Mz rotation with a 150% increase (3t /ha above the control), in plots with 50 kg P/ha MPR, while Mz-CB and SB-Mz rotation had similar maize yields regardless of the fertilizer applied. Crop rotation and application of P fertilizers had a highly significant interaction ($P=0.001$) and a positive impact on both total bacterial and fungal community. Significant increases in total community bacteria were noted in Mz-CB rotation system (1.48), followed by the SB-Mz (1.44) and CB-SB-Mz systems (1.42), while the total fungal diversity was significantly lower in the Mz-CB rotation (0.93), but higher in the SB-Mz system (1.12). Overall interactions between crop rotation and P fertilizers affected the total diversity of bacterial and fungal communities in the bulk soil but crop rotation was more important in determining the total microbial diversity than the fertilizers!

. There seems to be no significant correlation between the crop yields and the total microbial diversity, probably because soil sampling was done earlier in the season. Further work is required to monitor the changes of the total community structure within and at the end of the cropping season

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Changes in the microbial activity and biomass of soils from Mediterranean Mountain areas along an altitudinal gradient: interaction with tree species composition

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Silvicultural management practices, which are mainly aimed at planning growing stocks, ages of harvestings and their spatial and temporal distribution, at promoting regeneration and at regulating tree density and structural pattern need to consider ecological aspects as for example soil health and quality since soil is critical for ensuring the sustainability of the environment and the biosphere. If forest composition changes when silvicultural management is applied, predicting dynamics will require an understanding of how soil microbial function is altered. The aim of this work was to examine the effect of tree composition on the soil microbial community along an altitudinal gradient in Cuenca Mountains. Six experimental forest areas were selected. At lower altitudes (960 m.a.s.l.), a monospecific Spanish black pine (*Pinus nigra* Arn. ssp *salzmannii*) forest stand and a mixed forest stand (maritime pine-*Pinus pinaster* and Spanish black pine) where selected; at the most common and representative location of this species in the Cuenca Mountain (1200 and 1350 m.a.s.l.) two monospecific Spanish black pine forest stand were selected; at high altitudes (1670 m.a.s.l.), a monospecific Spanish black pine forest stand and a mixed forest stand (Scots pine-*Pinus sylvestris* and Spanish black pine) where selected. Climatic (air temperature and rain) and forest stand variables (i.e. tree species composition, tree height, basal area and shrub cover), physicochemical soil properties (i.e. soil moisture and texture, pH, carbonates, total organic carbon, organic matter, electrical conductivity, N and P) soil enzymes (Urease, phosphatase, β -glucosidase and dehydrogenase activities), soil respiration and soil microbial biomass were analyzed at the selected forests areas. Result showed that climatic variables were different at each forest area. Soil texture and organic matter also differed at each experimental area (P-value<0.05) but not between different forest stands composition (P-value>0.05). Results also demonstrated that soil respiration, soil microbial biomass and soil enzyme activities tend to be significantly lower at lower altitudes whereas no differences were found between monospecifics and mixed tree stand at any altitude (P-value>0.05). This work suggests that the soils of Cuenca Mountains may be more sensitive to changes in forest location than changes in tree stand composition, which should be taking into account on the sustainable forest management context.

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Evaluating Auxin hormone production ability of some indigenous pseudomonas fluorescent strains isolated from Iranian soybean cultivated farm lands

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Legumes are an important source of protein and their production is linked to food security. Previous studies have shown that some roots-associated bacteria called Plant Growth-Promoting Rhizobacteria (PGPR) can promote the growth and development of soybean. Several improving mechanisms of PGPRs including the production of phytohormones like IAA, ACC-deaminase and solubilization of mineral and organic phosphates have been proved by scientists all over the world. Pseudomonas fluorescent is one of the most efficient plant growth promoting rhizobacteria and for that matter the production of indole-3-acetic acid (IAA) is one of the major mechanisms by which it would enhance plants growth however by producing an appropriate amount of IAA. An in vitro experiment was conducted to determine the ability of 100 indole-3-acetic acid producing Pseudomonas fluorescent strains isolated from Iranian farmlands to detect IAA producing strains after an appropriate incubation period using Luria-Bertani (LB) medium supplemented with 100 mg/liter of L-tryptophan and Salkowski colorimetric technique. Results showed that all of the isolates were able to produce IAA in different quantities. There were significant differences among the isolates in the production of IAA ($P < 0.01$). The maximum amount of auxin were produced by isolates number 35, 28 and 58 which were the equivalent of 14.61, 9.17 and 8.92 mg/liter respectively and the minimum amount of that was produced by isolate 3 and the equivalent of 0.15 mg/liter. The majority of the isolates could produce one to five mg/liter of auxin. Our study clearly demonstrated that indigenous Pseudomonas fluorescent strains could highly produce indole-3-acetic acid (IAA) and hence be considered as a great potential to contribute to the productivity of soybean as a legume plant having a key role in the sustainable agriculture and offer many economic and environmental benefits due to enriching soil with available nutrients and organic matter.

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Seasonal effects on soil nutrient dynamics in halophyte grassland at Cuatrociengas valley, Mexico

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In the desert ecosystems, the plant productivity is constrained by the rainfall pulses, which is strongly seasonally. The plant organic matter input to the soil is the main energy and nutrients sources for soil microorganisms, which in turn, they are the principal actors for nutrient mineralization, resulting in nutrient availability for the plants. As the result, the ecosystems productivity depends on the interaction of plant and soil microorganisms, mainly in oligotrophic desert ecosystems. The present study analyzed the seasonal effects on soil nutrients dynamics in halophyte grassland at Cuatrociengas valley in the north of Mexico. This valley is characterized by arid climate with two contrasting seasons: summer (hot and wet) and winter (cold and dry). The mains soils are Calcisols derived from calcareous sandstone from the Jurassic, with very low P concentration (oligotrophic conditions). Ten composited samples from the top 15 cm depth were taken in the both season (summer and winter) and analyzed for nutrient dynamics with standard methods. The summer samples had higher dissolved organic forms (DOC, DON and DOP), microbial P and ammonium than the winter samples. Similarly, potential C mineralization under laboratory conditions was also higher in summer than in winter. However, microbial C and N had no differences among seasons. The results suggest that the microbial community is strongly constrained during the cold and dry season, concentrating their activity in the summer's months. Additionally to the water constrains, our results suggest that this ecosystems is also limited by P availability. Total soil P concentration was 0.1 mg g⁻¹, from which only 6% is plant available (around 5 µg g⁻¹). The potential C mineralization correlated with DOP in the summer samples, suggesting that the microbial activity is constrained mainly by P availability. These results suggest that the microbial processes are concentrated when both water and soil P are available. However, the soil P availability is strongly affected by soil DOC contents, because P mineralization is the dominant sources of available P. This study is an example of the strong interdependency between plant and soil microorganisms, which must facing water pulses. As a consequence, this ecosystem is very vulnerable to any human perturbation.

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Isolation and screening of potential plant growth promoting rhizobacteria from pastures established on a Chilean volcanic soil

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Agricultural production in southern Chile is based on acid and moderately acid volcanic soils with high nitrogen (N) fertilisation input. Pastures are often under a regime of fertilisation with ammoniacal fertilisers, which contributes to soil acidification process. In this study, bacteria associated with rhizospheric soils and with properties related to plant growth-promotion were isolated from pasture with (N1) and without (N0) long term N fertilisation trial. A total of 1,176 strains were isolated by using various general culture agar media and their beneficial mechanisms were identified. This rhizobacteria were screened on the basis of their phosphate-solubilising (PS), phytate-mineralising (PM) and indole acetic acid (IAA)-producing abilities. As compared with unfertilised soils, N fertilisation of the pastures decreased significantly the occurrence of IAA-producing rhizobacteria (3%) and increased the occurrence of PS+PM rhizobacteria (46%). About 12% of culturable rhizobacteria were PS+PM+IAA rhizobacteria. Twenty isolates, efficient in all assayed mechanisms, were chosen and characterized genetically, based on 16S rRNA gene partial sequence. This study showed that pasture established on volcanic soils contained significant bacterial populations, simultaneously expressing multiple traits (PS+PM+IAA) involved in plant nutrition and phytostimulation. Interesting results indicated that more efficient species in all assayed mechanisms belonging to the *Enterobacter* and *Serratia* genera were found in N0 and N1 plots. Besides, species belonging to *Pseudomonas* and *Bacillus* genera were only found in rhizosphere of pasture grown under N1 plot. Thus, we think that for biofertiliser formulations for pasture production with high N input, it is necessary to consider these more efficient bacteria genera to make plant growth more effective in volcanic soil.

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Potential of C retention in silt and clay fractions of a Brazilian subtropical Oxisol as affected by soil management systems

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The capacity of soil to sequester C is related to the formation of organo-mineral complexes. This study aimed to investigate the influence of soil management system on the C retention capacity of silt and clay fractions in a subtropical Oxisol cultivated for 30 years under no-tillage (NT) and conventional tillage (CT). Six soil layers (0-2.5; 2.5-5; 5-10; 10-20; 40-60 and 80-100 cm) were sampled from each site and from a neighboring area under native forest (NF), the latter was employed as a reference for the original carbon content in soil. After removal of particulate organic matter, the sieved suspension (<53 μm), was sonicated (1500 J mL⁻¹) and silt and clay fractions were separated according to Stokes' law. Carbon content in the whole soil and in the silt and clay fractions was determined by dry combustion. The C content in whole soil under NT decreased steadily with depth and varied from 58 to 18 g kg⁻¹. Similar behavior of C variation was observed under NF, with exception of the upper layer where C content was higher (109 g kg⁻¹). In contrast, the C contents of the soil under CT were relatively uniform within the first 20 cm (40 g kg⁻¹) and decreased to 13 g kg⁻¹ at 1 m depth. Regarding the fractions, the clay C content under NT varied from 19 to 58 g kg⁻¹ and that in silt from 12 to 52 g kg⁻¹. In both fractions the trend of C variation with depth was similar to those observed in the whole soil. The samples under NF presented a wider range of C content in both fractions (21 to 60 g kg⁻¹ in clay and 7 to 80 g kg⁻¹ in silt) while for the soil under CT the C variation range was narrower: 12 to 47 g kg⁻¹ in clay and 8 to 37 g kg⁻¹ in silt. These results evidence that soil cultivation under a conservative management system during 30 years tends to restore the original C contents, while the conventional tillage depletes C concentration in both fractions in the first 20 cm. The soil under NT showed a higher C saturation in clay (58 g kg⁻¹) and silt (52 g kg⁻¹) in the 0 to 2.5 cm layer in comparison to the soil under CT (47 g kg⁻¹ in clay and 37 g kg⁻¹ in silt). These results suggest that NT promotes C preservation in silt and clay fractions by organo-mineral interactions and by self-assembly of functional organic groups, which enhances hydrophilic and hydrophobic interactions in soil organic matter.

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Investigating the relation between soil mineralogy and microbial communities in a landscape study

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Microorganisms have a significant effect on releasing nutritional elements from minerals into soil through bioweathering. Their community composition can in turn be affected by elemental constituents of different types of rocks and minerals. There is evidence that mineral composition affects the structure of associated microbial communities in different environments including soil. However, most studies so far have focused on the relation between macronutrient constituents in minerals and microbial colonization, whilst micronutrients content of soil minerals may also affect this relationship. Micronutrients include trace elements that are essential for healthy plants, animals and humans. They are also required by microorganisms; e.g. rhizobia bacteria, which are known to require e.g. B and Mo for their survival as free-living soil saprophytes, as well as in their symbiotic relationship with legumes.

In this project we are studying how differences in the inherent mineralogy, as well as physical and chemical properties of the soils may affect the microbial community composition and how soils varying from low to high availability of micronutrients explain the diversity and abundance of agriculturally important microorganisms with particular focus on rhizobia. Soil samples, data and DNA archive of grassland and arable soils from the National Soil Inventory of Scotland (NSIS2) have been used. NSIS provide us with a set of soils representing a very wide range in parent material within a fairly limited geographical area with similar climate and land use systems. The physiological capacity of microbial community was determined by the MicroResp technique and was compared in contrasting soils. A molecular fingerprinting technique, T-RFLP, was used for a rapid assessment of the microbial community. Mineralogical studies were performed through quantitative analyses of minerals using X-ray powder diffraction. The data are being analysed by multivariate statistical methods.

Preliminary results show some patterns among the sites based on MicroResp data which is community level functional profiling of soil microorganisms. They will be further discussed due to probable influential factors describing the relation between soil mineral composition and microbial communities; and the findings will contribute to a better understanding of these relations which may in turn lead us into more efficient and site specific (micro) nutrient management strategies in agriculture.

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Microbial utilization of the C sources in functional SOC pools with regard to their stability and structural microbial community composition

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Soil organic carbon (SOC) is heterogeneously distributed among soil compartments into functional SOC pools of different quality and stability. These functional SOC pools can be isolated based on chemical and/or physical fractionation techniques without substantially changing properties relevant to their functions in ecosystems. A size - density fractionation of soils was applied to separate four functional SOC pools: (i) two clay-associated fraction (CF1: < 1 μm ; CF2: 1 – 2 μm) and (ii) two light fractions (LF1: < 1.8 g cm^{-3} ; LF2: 1.8 – 2.0 g cm^{-3}).

The presented results are based on data sets of two different ecosystems:

- (1) Extensively managed grassland sites of different productivity of the Thuringian and Franconian Forest in Central Germany (part of the BIOLOG-Europe Programme, called DIVA and funded by BMBF).
- (2) A pasture and natural prairie site in the forest steppe of the Kursk Institute of Agro-Industrial Production in Russia.

The main objective of the presented work was to link abiotic characteristics of functional SOC pools to biological processes. These pools were used as substrates in a respiration experiment in order to obtain deeper information on the decomposability and stability of these pools over time. Therefore bulk soil samples and isolated functional SOC pools were incubated at 22 °C in an automated respirometer (RESPICOND) for 10 days, where CO₂ evolutions were measured hourly. By phospholipid fatty acid (PLFA) extractions it was furthermore analysed how levels of functional groups within microbial communities change over time (start and end of incubation experiment) within functional SOC pools and how specific functional groups control decomposition processes of these pools. Our results indicate that functional SOC pool specific PLFAs were introduced to the control soil and the PLFA biomass was increased respectively. Depending on the C source the PLFA pattern and amounts changed during the experiment in relation to the expected availability / stability of the functional SOC pools and the soil type of the respective ecosystems. Thus we could demonstrate the structures of the communities during degradation of the SOC pools and evaluate the importance and function of fractions in soils.

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Applying ArcGIS Geostatistical Analyst for zoning of some soil biological properties affected by different land uses

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The ArcGIS Geostatistical Analyst aims to effectively bridge the gap between geostatistics and GIS analysis by enabling to model spatial phenomena and accurately predict values within the study area. In the present study, this approach was applied to forecasting the distribution patterns of some soil biological properties in Mirabad area of about 197 ha with 1325 m altitude in north west of Iran. Three different land-uses (apple garden, crop production, and rich rangeland) were selected to be conducted an experiment in a RCB design with five blocks. Soil samples (0-30 cm) were collected on middle July 2010. Soil biological indicators such as substrate induced respiration (SIR), microbial biomass carbon (MBC), and also alkaline phosphomonoestrerase (ALP), urease, and dehydrogenase (DHA) activities were determined. The Kolmogrov-Smirnov test performance revealed that all dataset have standard normal distribution. Therefore, they can be used in spatial statistics to predict the variation of soil biological properties in the passive points in terms of certain data and to create georeferenced map. As with many other spatial predictors, the inverse distance interpolation, a value of target variable at some new location is derived as a weighted average. Biological properties in these maps reclassified as five classes: very low (C1), low (C2), moderate (C3), high (C4) and very high (C5). The area extensions of each mapping unit are then calculated. The results showed that SIR is approximately equal to 0.021-0.024 mg⁻CO₂ g⁻1h⁻1 in 40% of the total area (C4) while 3% of the total area is classified as C1(0.003-0.012 mg⁻ CO₂ g⁻1h⁻1). On contrary, the maximum rate of MBC (C5) is scattered in 3% of the total area where its value varies from 7.277-91.962 mg C g⁻1. According to the obtained results, ALP, urease, and DHA activities have similar trends where the main part of the study area is classified as C2 and C3. ALP and urease in 42% of a total area were 1297-1750 µg pNP g⁻1h⁻1 and 526.527-699.037 µg NH₄⁺-N g⁻1h⁻1, respectively. Also, DHA activity as relative absorbance of Tri-phenyl furmazan at 546 nm was 0.049-0.087 which comprises about 40% of the area. The impact of different land uses on soil biological properties is fully addressed in this article

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Struvite formation by soil bacteria. Is the struvite a metaestable mineral in the phosphorous cycle in soils?

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Struvite is biomineralized by soil bacteria (especially halophilic) in the cultures in vitro; the induced biomineralization of this mineral is carried out in the cellular walls. However, rarely have described the presence of struvite in the natural soils, which can be explained by the general shortage of phosphate minerals in soil environment, or because it is a metastable mineral in these environments. Struvite ($\text{NH}_4\text{MgPO}_4 \times 6\text{H}_2\text{O}$ or $\text{KMgPO}_4 \times 6\text{H}_2\text{O}$), is abundant in materials from animal excrements and their organic debris (guano, animal manure, "ornitogenic soils" of Antarctic tundra, etc.). It also precipitates in the wastewater treatment plants, where it constitutes a problem for the obstruction of the conductions. The poured purified residual waters, still rich in P and N, it is a serious environmental problem for the eutrophication of rivers, lakes and reservoirs; so it appear in the bibliography numerous investigations about the possibility of forcing the struvite precipitation in residual waters and farm slurry. It have been also carried out researches using struvite as a fertilizer of low liberation rich in N and P, being demonstrated that their effectiveness is superior in some cases to others commercial fertilizers. In this study we investigated the struvite formation by the soil bacteria from the A and C horizons, of two saline soils (Gley-Gypsic-Carbonated Solonchack and Arenic-Gypsic-Hyposalic Solonchack); these bacteria were cultivated in vitro in culture media derived from the extracts 1:1 of the horizons (from where they were isolated) and from artificial saline solutions. In all culture media, after 10 days of incubation appear enough quantities of crystals to be isolated and analyzed by means of XRD and SEM-EDX. The crystals are mainly of aragonite, magnesium-calcite and struvite. The proportion of these minerals varies with the characteristics of the culture medium, the bacteria type and the time of incubation. The carbonates show a spherulitic morphology with different sizes (15 to 500 μm). The struvite appears as idiomorphic crystals with 50 – 350 μm of size. Potassium has been detected in some struvite crystals. We have been also demonstrated that the struvite crystals include carbonate-spherulites and viceversa. However, neither in the soil fine earth fraction (<2 mm) of the studied horizons (analyzed with XRD), neither in the accumulations of secondary soil carbonates (nodules and carbonate crusts, analyzed with SEM-EDX), phosphates are...

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High mountain environments in Patagonia Argentina: analysis of relations between plants, intraradical fungi and soil characteristics.

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High Mountain environments constitute variable terrestrial ecosystems with rigorous climatic characteristics. They comprise a floristic diversity adapted to harsh conditions, associated to a variety of habitats. Mycorrhizal fungi are considered to be a strategy of nutrient uptake and improvement in plants fitness. Mycorrhizas and Dark Septate Endophytes (DSE) of High Mountain environments in Patagonia Argentina have been scarcely analyzed. The functional interface between roots, fungi and edaphic characteristics could be one of the keys to understand these environments. The aim of this work is to study the relation between intraradical fungal colonization, plant species and soil characteristics, along a precipitation gradient (3500 to 500 annual mm) and different environments in high mountain sites and steppe environments in Patagonia Argentina. Three High Mountain sites (above timberline, 1600 m a.s.l.) and one Patagonian Steppe site (800 m a.s.l) were sampled. Also different environments were distinguished and analyzed: screes, meadows, forest and patagonic steppe. Nine plant species were sampled, all of them present in at least 3 sampling sites. Occurrence and quantification of mycorrhizal and DSE fungi were studied in all individuals. Analysis of soil and plant nutrients (P, C and N); soil pH and moisture content were determined. Pearson Correlation and Principal Component Analysis (PCA) were used. Eight species presented Arbuscular Mycorrhizal (AM) infection. DSE occurred in all species. Both types of infection showed a wide distribution and co-appeared in the different sites and environments. Soil nutrients availability showed no correlation with nutrients in aerial plant parts, positive correlations were found between AM and DSE infections and between this last two and plant C. Scree environments were grouped and characterized by low levels of soil nutrients. Steppe and meadow environments show intermediate values and the forest has the highest contents of soil nutrients. Previous studies concluded that root infection levels are regulated by amount of soil N and P. Is not the case of these particular environments, were benefit and cost balance of sustaining root symbionts is delicate. The wide occurrence of intradical symbionts highlights them as an important strategy in plant nutrient assimilation in Patagonic High Mountain, and the relation between intraradical fungi and their host might be the prevalent regulation process in root infection.

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Influence of stand quality on soil properties in thermophilic Spanish juniper woodlands (*Juniperus thurifera* L.) in South-Eastern Spain

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This paper highlights a quantification of soils properties (enzymatic activity, soil respiration, organic C and physical and chemical parameters) in thermophilic Spanish juniper woodlands (*Juniperus thurifera* var. *hispanica* Mill.) located in south-eastern Spain. J.t. is an endemic species of the East Mediterranean, but the variety *hispanica* is only found in Spain and the French Pyrenees. Due to its singularity it has been included in the Regional Catalogue of Endangered Species in Castilla-La Mancha Region. Despite its ecological importance, few previous studies have been carried out in thermophilic *Juniperus thurifera* var. *hispanica* woodlands to analyze soil properties and respiration. For this purpose, parameters that estimated microbial activity (soil respiration and organic C), enzymatic activity (urease, phosphatase, β -glucosidase and dehydrogenase), and physical and chemical parameters (organic matter, soil nitrogen, phosphorous, C/N ratio) were evaluated during the 4 seasons in Spanish juniper woodlands. Data collection was carried out at El Campo de Montiel (southeast Spain). This fragmented juniper woodland, covering 16,515 ha, represents one of main semi-arid Spanish juniper distributions. Soils for analysis were selected from two monospecific juniper stands in the study area:

i) a mature open stand in rocky soil and ii) a younger closed juniper stand in deeper soils (abandoned farmland).

Results obtained shows that both site and season correlated with all principal soil parameters estimated. A significant correlation was also found between microbiological, biochemical and physicochemical parameters. The results obtained in this paper shed new light on the habitat of a coniferous species, which up until now had not been studied in depth, despite its great ecological importance. Additionally our study confirms that this habitat shows important singularities at the worldwide level in the study area, and hence should be regarded as a “relic forest” representing the testimony of vegetation that dominated the earth probably millions of years ago.

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Phytate mineralising rhizobacteria are associated to common-bean nodulated root

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In the context of a more sustainable agriculture based on the reduction of mineral fertilizers as Inorganic phosphate, we need to better understand the potential of use of organic soil P as P source for plants that acquire P as inorganic P, exclusively. Within organic P, Inositol phosphates (phytates) are the dominant class of organic phosphorus (P) compounds in soils; it is generally estimated to contribute to at least 50% of total organic soil P. In order to become available for plants organic P must be mineralized by phosphatases, mostly originated from the soil microbial community. Phytases are the most active phosphatases for the dephosphorylation of Inositol phosphates. The aim of this work is to characterize the functional microbial community involved in the mineralization of phytate in the rhizosphere of a leguminous plant. Phytate-mineralizing bacteria were isolated using a selective media from the rhizosphere of common bean (*Phaseolus vulgaris*) growing in soil. The density of phytate-mineralizing bacteria was higher in the rhizosphere of beans cultured on low P soil compared to a P-fertilized soil, and represented 1% of the microbial community in the rizosphere of common bean. The phytate-mineralizing bacteria selected in this work belonged to Enterobacter, Pseudomonas and Pantoea families according to the sequencing of 16S DNA. The capacity of those isolates to release inorganic P (Pi) from Na-phytate and to use phytate as a sole P source was confirmed in broth. It is concluded that phytate-mineralizing bacteria can be found in the rhizosphere of a nodulated legume and that communities of phytate-mineralizing bacteria are more important when the rhizosphere is deficient in P.

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Characterization of soil organic matter and cyanobacterial diversity of microbiotic crusts in a desert scrub of the Baja California peninsula, Mexico

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Microbiotic crusts are important colonizers of desert soils. Their importance in stabilizing soil particles at the surface has been extensively documented because cyanobacteria form a web of filaments that secrete exopolysaccharides. We expected to find differences in the quantity and quality of organic matter content related to these crusts. The field study was performed in the arid region of the southern part of the Baja California peninsula in soils that are sandy, deep, well-drained, pale in color, and neutral-to-moderately alkaline. Microbiotic crusts were collected from eroded soils and scrubland soils. Based on surface appearance, we found flat crusts on eroded soils and rough crusts on scrubland soils. Stereoscopic and bright-field microscopy showed that filamentous cyanobacteria were dominant in both crusts, most species belonging to *Microcoleus*. Rough crusts had lichens, but had fewer cyanobacterial species (6 spp.). Flat crusts were more diverse (9 spp.). Soil samples were collected from four distinct areas and their total organic carbon measured ($\text{g}\cdot\text{kg}^{-1}$): eroded soil with crusts (39), eroded soil without crusts (34.1), scrubland soil with crusts (56), and scrubland soil without crusts (68). The C:N ratios ranged from 3.4 for eroded soils to 12.2 for scrubland soils. For the same four distinct soil areas, fractioning of humic substances clearly demonstrated more humic substances (humic acid + fulvic acid) in soils with crusts (1107, 341, 923, and 526 $\text{mg}\cdot\text{L}^{-1}$, respectively). The values of the E4:E6 ratio, which is inversely related with progressive humification, were 12.0 for eroded soils without crusts, 10.7 for eroded soils with crusts, 10.3 for scrubland soils without crusts, and 9.7 for scrubland soils with crusts. The results demonstrated that the poorest conditions were eroded soils without crusts and the best conditions were scrubland soils with crusts, as expected. A detailed analysis of soil texture showed that crusts retained clay and silt particles, which are otherwise easily dispersed by wind. Chumin content (1.48 to 0.58) demonstrated the importance of the so scarce clay-silt fraction to stabilize soil carbon in arid soils. In turn, this leads to potential for carbon sequestration in soils of arid ecosystems as organo-mineral complexes and the role of microbiotic crusts to reduce soil erosion. Biochemical classification of the humus is xero-moder.

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Multi-parameter approach to assess short-and long-term effect of olive mill waste water land spreading on soil quality

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The disposal of olive mill waste water (OMW) represents a relevant issue in Mediterranean countries, where the production of olive oil is large and concentrated in a short-lasting period. OMW can be used as an organic amendment in cultivated soils due to its high content of organic compounds and plant mineral nutrients. Therefore, OMW field spreading may represent a low cost and a contribution to crop irrigation in arid or semiarid climatic conditions. However, from an environmental point of view, the chemical composition of OMW might cause soil and/or water contamination. Some studies were performed aiming to evaluate the effect on crop yields and/or soil properties of OMW applied at different rates in controlled conditions. So far, field studies, focusing on the assessment of physico-chemical soil parameter changes after OMW application, are less. Here, we studied short- and long-term effect of OMW field spreading on soil chemical and biochemical parameters together with the impact on arbuscular mycorrhizal fungal (AMF) root colonisation. The study was carried out in two sites in Tuscany where 80 m³ ha⁻¹, corresponding to the highest amount allowed by Italian law, was applied. The experimental layout followed the scheme of a completely randomised design with two treatments (OMW-amended soil and untreated soil as control) and four replicates. Soil and root samples were collected at zero time (T0) and 300 days after field spreading (T300). Soil samples were analysed for pH, electrical conductivity (EC), available and total P, total N, nitrates, ammonium, soil organic carbon (SOC), exchangeable K (K_{exch}), soluble phenols, lipids, microbial biomass carbon (MBC) and soil respiration (SR). In addition, AMF colonisation was determined on roots of collected spontaneous plant species. In T0, OMW application significantly affected EC, nitrate, ammonium, K_{exch} and soluble phenols, while in T300 only EC, total P and K_{exch} were significantly different. MBC and SR largely decreased in T0. Moreover, at both times, AMF colonisation in OMW-amended soil was significantly lower than in the control. This study confirms the positive effects of OMW on soil mineral availability, which is supported also by the fact that phenols increased only for a short-time after the application. By contrast, AMF root colonisation decrease might be related to a reduction of the beneficial effects of such important symbionts, although further studies are needed.

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Organic amendments as tool for a sustainable management of intensive agriculture

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The growing demand of food and the necessity to increase crop yields have prompted farmers to adopt more intensive cultivation techniques. Intensive agriculture determines a decrease of soil quality mainly due to a strong organic matter (OM) reduction. Under greenhouse cultivation crop residues are systematically eliminated to limit plant diseases, the optimal temperature and water content, jointly with the continuous soil tillage, promote OM mineralization. Use of organic amendments is generally seen as a key tool for soil health and sustainability in intensive agriculture systems, in order to preserve OM amount, supply plant nutrients and, thus, promote soil quality.

Aim of this work was to study the recovery of fertility in agricultural soils cultivated under permanent plastic cover, by supplying organic amendments. The study has been carried out in two farms located in Southern Italy with contrasting geopedologic characteristics (clay vs sandy soil) for two years. Mixtures of organic amendments prepared with compost from municipal solid waste, as source of easily degradable OM, and wood (scraps of poplars pruning), as slow degradation source, were yearly supplied (30 and 60 t ha⁻¹).

After addition of organic amendments, soil fertility was periodically monitored for chemical properties (pH, electrical conductivity, CEC, organic C, total N, ammonium-N, nitrate-N, available phosphorus, Ca²⁺, Mg²⁺, Na⁺, K⁺) and enzymatic activities (dehydrogenase, beta-glucosidase, invertase, phosphatase, urease, arylsulphatase and fluorescein diacetate hydrolytic activity).

Results showed generally positive effects of organic amendments on soil chemical properties, in particular as improvement in organic carbon and nutrient contents, as well as in enzymatic activities. The OM recovery was obviously related to the amount of organic amendments applied, but even to the geopedologic characteristics of the different farms. Our results demonstrated that the use of compost enriched with low mineralization materials, such as wood scraps, can enhance soil chemical and biochemical properties, thus representing a promising alternative to the conventional exclusive use of synthetic fertilizers.

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Evolution of microbial populations and its relation with humic and fulvic acids availability in a composting process

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Production of muscatel grape for Pisco industry represents one of the most important activities in Chile; Pisco is defined as a distillate from the muscatel grape fermentation, its production generates a large amount of residues (12-15 ton/ha), this material is organized in deposit area losing its nutrient and fertilizing potential. However, technologies as composting, in which the microbial activity mineralize the OM, permits a correct disposal of wastes, and provide compost for soil application, changing the interaction of soil microorganisms and improving the soil quality in terms of physical, chemical and biological properties.

The main objective of this research was to evaluate the evolution of microbial populations and its relationship with the production of humic and fulvic acids. Different treatments were set, using different substrates (grape pomace, bunch raquises, horse and goat manure, and pruning oat residues) with a total of 11 treatments (3 replicates). The experiment was performed on Limari Valley using the turned pile system with periodic turning (each 10 days), during a 180-day period. Microbial populations, (heterotrophic bacteria [HB], fungi and yeast [FY], phosphate solubilizers [PS], cellulolytic [CM] and amilolytic microorganisms [AM]), chemical properties (pH, humic acids [HA] and fulvic acids [FA]), human pathogens (*Salmonella* sp.), and fecal microbiological indicators (coliforms and *E. coli*) were determined. Main effects were evaluated comparing means by ANOVA, using Tukey test ($p < 0.05$). Correlation analysis among variables was also carry out in SPSS 9.1.

Some microbial population as HB and FY, are involved in the production of hydrolytic enzymes, such as B glucosidase, phosphatase and urease which starting out the process of mineralization of organic matter. Later humification process occurs with the formation of HA and FA. As results some microorganisms associated to OM degradation as (CM, PM, AM) show concentration of 5×10^8 ufc/g on the before maturity phase of composting. After thermophilic phase decrease to 1×10^6 ufc/g. Goat manure and grape pomace induced the highest production of HA (8,6%). Positive correlations were observed among some populations (HB, FY, and AM); the changes in the availability of specific carbon sources as cellulose, resulted in a negative correlation between HA and CM.

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Effect of selenium seed pelletization on rhizobacteria associated with cereal crops grown in an Andisol

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Selenium (Se) is a trace element with antioxidant properties. In Chile, cereal crop production, such as: wheat, oat and barley are the most important nutrient source for population and crops frequently have suboptimal selenium (Se) levels due to many factors, such as plant species, soil type, fertilization and selenium forms available in soil. The application of Se-fertilizers has proven to be an effective way to raise the Se concentration of crops grown in Se-deficient soils. However, there are no studies focused to evaluate the effect of Se on bacterial populations in agricultural soils during Se plant biofortification. In this study, we investigated the effect of Se-seed pelletization on the structure of rhizobacterial community and Se-tolerance culturable rhizobacteria (SeTCR) associated with cereal crops (wheat, oat and barley) growing in Se-deficient Andisol. For this purpose, the cereal crop seeds were supplemented with Se at different doses (25, 50, 100 and 150 g ha⁻¹ equivalent). After 5 weeks of plant growth under greenhouse, rhizosphere soil samples were taken and analysed. Controls without Se supplementation were also evaluated. The rhizobacterial community was analysed by PCR for Denaturing Gradient Gel Electrophoresis (PCR-DGGE) and for SeTCR count, dilutions of samples were in plates on nutrient agar supplemented with 2 mM sodium selenite. The results did not show effect of Se supplementation on SeTCR load and bacterial communities assessed by DGGE. Surprisingly, we found a significant number of SeTCR (104-105 CFU g⁻¹ soil) present in Andisol, which is recognized as Se-deficient soil. The presence of SeTCR in this soil remains unknown. In addition, cluster analysis of DGGE bands revealed differences of plant species, between specific rhizobacterial communities for each plant type. It is known that plant species may govern the structure of bacterial group in the rhizosphere. Our results indicated that a) the Se doses usually used in plant biofortification do not affect the rhizobacteria populations associated with cereal crops grown in Andisol and b) rhizobacteria present in Se-deficient Andisol have an unexpected ability to tolerate high Se concentrations. Further investigations are needed to evaluate the mechanisms involved in Se tolerance by this rhizobacteria.

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Integrated use of arbuscular mycorrhiza fungi and fertiliser: effects on soil clay assemblage

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Potassium is a major element for plant nutrition. In soil, K availability is affected by 2:1 clay minerals adsorbing and releasing K⁺ ions from interlayer sites. Essentially two sources of K are present in the soil clays: (i) exchange sites, where the presence of K is a function of the ambient fluid concentrations of competing ions and the overall ionic strength of the solutions; (ii) non-exchangeable K which is not easily extracted by cations in solution. This fixed K is usually seen as an illite layer, i.e. an anhydrous K layer that forms a 1.0 nm structural layer unit as seen by X-ray diffraction. Plants can extract K from both of these sites in the clay mineral structures. In the root zone, microorganisms such as arbuscular mycorrhiza fungi can enhance nutrient availability and uptake increasing the use efficiency of fertilizers. The objective of this study was to identify the effects of non-inoculated and *Glomus intraradices* inoculated corn plant (*Zea mays*) growth under different experimental conditions on soil K-bearing clay minerals. The soil, a Vertic Xerofluvent, representative of the lowlands of the Volturno river basin (Campania Region, south Italy), was planted in corn (cv. Abgaro) and samples were from a field experiment arranged in a randomized block design during the period 2008-2010. Sampling (bulk and rhizosphere soil) was carried out from May to September 2010 from fertilized plots (N200P90K160 and N200P0K160) with and without plants. According with XRD analysis, three major K-bearing minerals were present in the studied soils: smectite-rich mixed layer mineral, illite-rich mixed layer mineral and illite. The relative abundance of illite and smectite type of layer in a soil clay assemblage can be estimated by the center of gravity of the decomposed X-ray patterns. Results at 40DAS indicate extraction of K from clay minerals by plant uptake, whereas it appears that at 130DAS much of the nutrient seems to be returned to the soil. There is an apparent difference between bulk and rhizosphere soil clays. The XRD patterns are not univocally affected by inoculation with *Glomus*. There are observable changes in clay mineralogy in fallow unfertilized compared with fertilized soil. In the studied soil, the illite rich mixed-layer minerals seems to be the source of K absorbed by plants, while the illite mineral acts as sink of K released from the plant-microorganisms system at the end of the growing season and as source for the following crop.

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Linking Genomic Structure to Function in Soil Aggregates

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Soil aggregates are the physical building blocks of soil. As an alternative to homogenized or bulked samples, studying individual aggregates as discrete units of microbial habitats presents more constrained communities than bulk soils. Currently, the complexity and diversity of sequences derived from bulk soils can overwhelm and obscure specific functional relationships. We have sequenced individual soil aggregates from the near-surface of a Palouse silt loam in Washington State, USA. We found from 800 to 50,000 sequences, and 27-800 unique OTUs (operational taxonomic units) per aggregate. To link function to this genomic structure, we have assayed both ATP content and β -glucosidase activity in individual aggregates, then pooled the most active aggregates for DNA extraction and sequencing. ATP varies more widely among aggregates than β -glucosidase in those same aggregates. Microbial colonization of soils is patchy, but it seems that the patches, as seen in individual aggregates, are highly variable. Linking these constrained communities to the measured process is an important early step toward demonstrating and understanding functional redundancy in terrestrial microbial communities.

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Phosphorus uptake and phosphatase activity under different phosphorus and nitrogen fertilization of Chilean Andisol pastures

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Plants acquire Nitrogen (N) from soil solution as either nitrate (NO₃⁻-N) or ammonium (NH₄⁺-N), and the uptake of different N sources influences the rhizosphere pH and the availability of essential nutrients like Phosphorus (P). Phosphorus is a very limiting nutrient for pasture production in Southern Chile, mainly due the high P fixing capacity of its volcanic ash derived soils. Under to P deficiency, plants and microorganisms secrete acid P-ases in the soil as a response mechanism to increase P hydrolysis and its uptake. A series of short-term experiments were carried out to assess the effect of P and nitrogen (NH₄⁺-N or NO₃⁻-N) fertilization on P uptake and phosphatase activity in ryegrass and tall fescue cultivated under greenhouse conditions. Ryegrass or tall fescue plants were grown in an acidic Andisol in the presence or absence of P and increasing doses of NO₃⁻-N or NH₄⁺-N fertilizers. At the end of the experiment, soil phosphatase activity (P-aseRhiz), pH, and Olsen-P were determined in the rhizosphere soil. Plant biomass, P uptake, and root surface phosphatase (P-aseRoot) were also assayed for both plant species. Furthermore, soil incubation experiments at increasing doses of P, NO₃⁻-N, or NH₄⁺-N were performed to evaluate the fertilizer effect on soil phosphatase activity (PaseBulk) and microbial biomass carbon in the bulk soil. In the absence of plants, P-aseBulk was inhibited and microbial biomass carbon was raised at increasing P supply levels. In the greenhouse experiments, P uptake by tall fescue was about 67% higher than that of ryegrass at low soil P availability, which suggests that tall fescue was less sensitive to P deficiency than ryegrass. For both plant species, P-aseRhiz did not vary as a consequence of P addition. On the other hand, fertilization with the highest NH₄⁺-N dose strongly decreased soil pH and shoot P content, as well as it increased P-aseRoot activity. This fact denotes that P-aseRoot behaved as a strategic response parameter to P stress with insufficient impact on plant P nutrition in both plant species.

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Phytate-induced selection of rhizobacterial community present in pastures from volcanic soils

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Phytate-degrading rhizobacteria are being considered as potential microbial inoculants for improving phosphorus (P) uptake by plants grown in soils with high content of fixed phytates. Here we evaluated in vitro the phytate-induced selection of rhizobacterial community present in pastures from volcanic soils (Andisol) of two regions of southern Chile: Los Ríos (Andisol Liquiñe and Andisol Valdivia series; 39°S, 72°W) and La Araucanía (Andisol Freire series; 38°S, 72°W). The survey included samples of rhizosphere soils (in triplicate) from natural pastures (Andisol Liquiñe series) and established pastures (Andisol Valdivia and Andisol Freire series) that had been managed with or without applications of nitrogen (N) fertilizers for different periods of time. Rhizosphere soil samples were enriched in culture broth containing insoluble phytate as sole P sources. Every 48 h, the bacterial cultures were transferred to fresh broths, and after two weeks, the total DNA was extracted and subjected to denaturing gradient gel electrophoresis (DGGE) and cluster analyses to determine and compare the structure of rhizobacterial community between pastures. A mixture of all pastures was also assayed. The DGGE technique revealed differences in the adaptation of rhizobacterial communities under phytate selection in the laboratory. Also, the cluster analysis showed that long-term N fertilization resulted in changes in the structure of phytate-degrading rhizobacterial community in pastures grown in the same soil type (Andisol Freire series). When all rhizosphere samples were mixed, the band pattern was also different compared with other pastures, including the appearance of new specific bands. This study shows that management and chemical fertilization may significantly affect the occurrence of phytate-degrading rhizobacteria present in the rhizosphere, even in pastures grown in the same soil type.

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Do feeding on soil increases N₂O emission ?

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For some key elements of the macrofauna, like earthworms or termites, soils represent both a substrate and habitat. Some previous studies have shown that, earthworms (for N₂O) and soil feeding termites (for CH₄), are important contributors of greenhouse gas emission (GES). These results seem to indicate that feeding on soil could contribute to an increase of these GES emission. Termites represent a suitable model to investigate this question because the 3000 different species are able to feed on a wide range of organic matter including wood, plant debris, roots, litter and soil humus. Thanks to their symbiotic gut microbial community, these insects are an important biological source of atmospheric methane, and the production level is related to the different feeding guilds (wood feeders, litter feeders, soil feeders). This study is based on the hypothesis that because of the low C/N ratio of soil compared to the other substrates like wood, soil feeding termites are potentially a higher emitter of N₂O. To test this hypothesis, we investigate the N₂O emission of 18 termite species representative of the three main feeding guilds, wood feeders, litter feeders, and soil feeders. We also test the importance of termite nest on this N₂O production. The density of the denitrifying bacterial communities was also measured using molecular techniques (qPCR) targeting the different functional genes involved in the denitrification processes. N₂O emission rates were higher in soil feeding termites compared to the other feeding habits tested, which confirmed our main hypothesis. There was a significant correlation between N₂O emission rates and density of bacterial denitrifiers genes within the different termite guts. For the nest, the differences in terms of N₂O emission, within the different feeding guild, were more species dependent. Interestingly, for the soil feeders species, we measured a noticeable stimulation of N₂O emission rates when termites were incubated with nest fragments. As the nest harbors a higher density of denitrifiers than the guts, we hypothesize that this N₂O stimulation could originate from the transit of the nest bacterial communities through the gut where they found more suitable physico-chemical conditions for the denitrification process. These results confirm that soil-feeding behavior contributes to GES emission and affects the dynamics of N in tropical soils.

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Effect on the total and functional bacterial community in amended soils with olive oil waste

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The use of pesticides in agriculture, especially herbicides, is a recognized advantageous practice all over the world. The excessive use of these compounds in soils over the last decades, have led to contamination of surface and groundwater. The addition of organic waste from olive oil production (OW) as alperujo to soils, controls the dispersion of pesticides and enhances the soil physicochemical properties. The aim of this work was to study the effect on the indigenous microbial communities of the addition of herbicide MCPA (4-chloro-2-methylphenoxy acetic acid) and alperujo to soils from Vega del Guadalquivir, Spain. Soil microcosms containing in a sandy soil (ARCO) and a loamy soil (TOCINA) amended with residue from OW production (5% and 10%) were used. Changes in the total (DNA) and functional (RNA) microbial populations were monitored using culture and culture independent methods. The major changes in the microbial population were observed in the amended soils using denaturing gradient gel of electrophoresis (DGGE)-16Sr RNA. Taxa with 99% 16S rRNA sequence similarity to Oxalobacteraceae and Janthinobacterium were found in extracts from T+OW (10%) soil before application of MCPA and 99% 16S rRNA sequence similarity to Acinetobacter were found in soils after 45 days of herbicide application. Mineralization and respiration of MCPA of unamended and amended at 5% and 10% with OW (w:w) ARCO and TOCINA soils, revealed a decrease of MCPA mineralized at the same time the CO₂ produced by soil organisms is increased with the addition of OW. The addition of OW to the soil microcosms increased the microbial population using organic carbon from OW instead of the herbicide MCPA.

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Dynamic changes in bacterial communities during compost and earthworm treatment of low grade potassium ore

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In order to explore the processing condition and to understand the bacterial diversity in biological conversion of low grade potassium-bearing ore, we composted ore powder and treated the compost with earthworm, and then studied bacterial communities in the compost and earthworm treatment with denaturing gradient gel electrophoresis (DGGE). Results indicated that both compost fermentation and earthworm treatment released bioavailable potassium. Compost fermentation increased available potassium by 37.36%, and earthworm treatment further increased available potassium by 9.77%. Bacterial community structure changed very quickly during the early stages of solid-state fermentation, but relatively stable in the later stages of fermentation and during earthworm treatment. The dominant species of bacteria largely varied in the earlier stage of composting, but they were stable in the latter stage and during earthworm treatment. Two classes of bacteria, represented by band 12 (likely *Alteromonas*) and band 14 (likely Firmicutes) in DGGE profile, were found to be dominant species over the entire solid-state fermentation period. No special dominant bacterial species appeared during earthworm treatment. Phylogenetic studies of the bacteria based on 16S rRNA sequences indicate that major 13 bands came from phyla Proteobacteria and Firmicutes, suggesting that bacteria in these phyla played an important role during the compost treatment.

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Nitrogen fixation and rhizodeposition of a metallicollous symbiotic association *Anthyllis vulneraria*/Mesorhizobium metallidurans grown in highly contaminated mine tailings by Zn, Pb and Cd

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Reclamation of mine tailings by phytostabilization remains difficult due to the excessive concentrations of toxic heavy metals in the soil and the very low nutrients availability. Frérot et al. (2006) showed that a Fabaceae, *Anthyllis vulneraria*, was able to improve cover and plant biomass when introduced in mixture of plants species native from the mining area. These species were well-adapted to water stress conditions of the Mediterranean region. The symbiotic partner of *A. vulneraria* was identified as *Mesorhizobium metallidurans* sp. nov. (Vidal et al., 2009) and this association was able to fix 80% of its total nitrogen in mine tailings (Mahieu et al., 2011). Our objective was to quantify the total below ground N (BGN), i.e root N and N released from roots into the soil by rhizodeposition, of the symbiotic association *M. metallidurans*/ *A. vulneraria* grown in a highly polluted mine tailings in Zn, Pb and Cd from the Mediterranean region.

Plants of *A. vulneraria* subsp. *carpatica* inoculated with *M. metallidurans* were grown on mine tailings from November 2008 to July 2009. The experiment was conducted in 161 pots under a tunnel covered hall. In situ ¹⁵N-cotton-wick labelling method and ¹⁵N dilution technique were used to quantify the N rhizodeposition and the nitrogen fixation by *A. vulneraria* during a growing season, respectively.

At plant maturity, shoot dry weight and N content of *Anthyllis* plants were around 4.9 ± 1.1 g plant⁻¹ and 73.9 ± 21.9 mg plant⁻¹, respectively. The root system was subdivided in i) 'mature roots', ii) 'root hair zone with inner rhizosphere' and iii) 'apical roots'. Dry weight of the different root samples were 1.0 ± 0.3 , 2.0 ± 0.9 and 0.3 ± 0.1 g plant⁻¹, respectively. The N concentrations in mature (2.0 ± 0.4 %) and fine roots (1.3 ± 0.4 %) were higher than in the 'root hair zone with inner rhizosphere' (0.4 ± 0.1 %; $P < 0.01$). The total BGN of plants collected at maturity was 43.5 ± 4.2 % of total plant N. The N rhizodeposition was 59.9 ± 7.9 % of the total BGN. The plants fixed 70.4 ± 2.5 % of their total plant N. In the experiment of Frérot et al. (2006), the N contribution of the legume would represent around 104 kg N ha⁻¹ year⁻¹.

The ability of the symbiotic association *M. metallidurans*/ *A. vulneraria* to develop a high nitrogen fixing potential, opens new possibilities for promoting a low-maintenance plant cover in highly metal-contaminated soils in the Mediterranean region.

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Ectomycorrhizal fungi and mobilisation of organic phosphorus from forest soil: myth or reality?

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Forest soils contain a high proportion of phosphorus (P) in organic form (Po) represented by phosphomonoesters (such as glucose 1-P, ATP, phytate, ...) or phosphodiester (such as nucleic acids or phospholipids). To be used by trees, the phosphate group (Pi) must be released by the hydrolysis of the ester bond by phosphatases (Pases). It has been hypothesized that ectomycorrhizal (ECM) fungi, able to release phosphatases in their environment, could play an important role in the recycling of P in forest soil, thus contributing to plant P nutrition. We addressed this question in the context of the maritime pine (*Pinus pinaster*) forest representing the first planted area in France. This forest is established on sandy podzol very poor in available Pi but high in Po contents relative to total P contents, making P limiting for tree growth. Field studies showed a high degree of mycorrhizal symbiosis.

To assess the efficiency of fungal Pases on organic P hydrolysis, we used *Hebeloma cylindrosporum*, a fungal ECM species isolated from maritime pine plots, able to release significant amounts of Pase activity when grown in vitro in P-starved conditions. Using cation-exchange chromatography, we separated four fractions with AcPase activity. Each AcPase active fraction displayed strong ability in vitro to hydrolyse a wide range of phosphate monoesters, but none of them efficiently hydrolysed phytate. In vitro measurements showed that up to 11% of the NaHCO₃-extractable Po from intact soil was phosphatase reactive. This value reached 50% in soils autoclaved previously (Louche et al. 2010, FEMS 73: 323-335). Taken together, these data suggest that AcPases secreted from *H. cylindrosporum* could be much more efficient in recycling microbial organic P pools that may be delivered by soil autoclaving than other soil organic P.

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Effect of organic amendment on the microbial growth, activity and functional diversity of a soil under intensive agricultural management

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Organic matter content can affect soil quality both directly, by releasing macro- and micro-elements, and indirectly, by determining changes in soil physical and chemical properties and stimulating, in turn, microbial growth and activity. Therefore, agricultural management practices including use of organic amendments could improve chemical and biological properties of soils, preventing depletion in its quality. A previous study has shown that in the Sele River Plane (Campania Region, Southern Italy) the intensive agricultural management, maintained for long time, negatively affects soil physical, chemical, biochemical and biological properties and bacterial community structure and functioning. Aim of this study was to analyze the effect of organic amendment on the microbial growth, activity and functional diversity in agricultural soils under intensive cultivation of two farms, with different geopedologic characteristics, in the Sele River Plane. In each farm, eight different treatments with organic amendments were yearly supplied, for two years in succession: two compost-poplar wood mixtures with different C/N ratio (15 and 25), two different amounts (30 and 60 t ha⁻¹), with or without a mineral fertilizing treatment in addition. Plots without organic amendment treatments, but with or without a mineral fertilizing treatment, were used as control. Soil samples, collected periodically after treatments, were analyzed for total microbial biomass (assessed as microbial carbon), soil potential respiration and functional diversity of microbial populations (by BIOLOG EcoPlates™). Moreover, C/N ratio and microbial indices (i.e., C_{mic}/C_{org}, qCO₂, CEM) were also calculated. Results showed in both amended soils a generally prompt increase in organic carbon, microbial growth, potential activity and functional diversity, compared with untreated control soils, but different intensity effects were found in soils of the two farms. No clear difference was pointed out between treatments and no evident effect was found in plots treated with mineral fertilizers, compared to plot treated with organic amendments only. All together, data substantiated the hypothesis that a general improvement in soil biological characteristics can occur after addition of organic amendments (no linked to addition of mineral fertilizers) in soils managed for long time by intensive farming.

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Bacterial community structure and enzymatic activity in an agricultural volcanic soil of southern Chile as affected by addition of sludge from pulp and paper industry

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The pulp and paper industry produces large quantities of sludge (by biological wastewater treatment) which is generally rich in organic matter, such as organic compounds (cellulose, lignin, etc.), microorganisms (bacteria, fungi, protozoa, etc.) and inorganic substances (nitrogen, phosphorus, clay, metals, etc.). It has been described that the controlled disposal of sludge in soils can affect positively its structure, water holding capacity, cation exchange capacity, pH and nutrient content, increasing the crop yields.

The aim of this study was to analyze the effect of successive applications of cellulose industry stabilized sludge on bacterial diversity and enzymatic activity (having fundamental role in soil healthiness and functions) of an agricultural volcanic soil of southern Chile.

This survey was conducted on a volcanic soil in an experimental farm managed by La Frontera University (Temuco, Chile), under *Lolium perenne* cultivation. Five successive applications per year of stabilized sludge (every 3 months) in three different doses (10, 20 and 30 t ha⁻¹ of sludge) were applied on the pastures, and plots without sludge treatments were used as control. Soil samples were collected 3 months after each application and the bacterial community structure (by PCR-DGGE, 16rDNA gene) and enzymatic activities (FDA-hydrolase and acid phosphatase) were analyzed.

The results showed that applications of sludge on soil did not cause a long-term effect on bacterial community structure, even when high doses were applied. However, in the first sampling, an increase in the number of bands in soil treated with higher sludge doses (20 and 30 t ha⁻¹) was observed, indicating the stimulation of diverse groups compared with lower dose (10 t ha⁻¹) and control. At this time the hierarchical cluster analysis confirmed this difference found in the bacterial community structure of soils amended with 20 or 30 t ha⁻¹. A high variability was found among samplings and treatments for enzymatic activities, but generally an increase in FDA-hydrolase and acid phosphatase activities was measured. Therefore, results indicated that application of pulp mill sludge to agricultural soil can improve soil quality by positive response of bacterial community. However, further studies need to test the magnitude and stability of beneficial changes deriving from sludge use as well as what microbial groups are stimulated by sludge application.

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Microbial uptake of low-molecular-weight organic substances outcompetes sorption in soil

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Low-molecular-weight organic substances (LMWOS) such as amino acids, sugars and carboxylates, are rapidly turned over in soil. Despite their importance, it remains unknown how the competition between microbial uptake and sorption to the soil matrix affects the LMWOS turnover in soil solution. This study describes the dynamics of LMWOS fluxes (10 μm) in various pools (dissolved, sorbed, decomposed to CO₂ and incorporated into microbial biomass) and also assesses the LMWOS distribution in these pools over a very wide concentration range (0.01–1000 μm). Representatives of each LMWOS group (glucose for sugars, alanine for amino acids, acetate for carboxylates), uniformly ¹⁴C-labelled, were added to sterilized or non-sterilized soil and analysed in different pools between 1 minute and 5.6 hours after addition. LMWOS were almost completely taken up by microorganisms within the first 30 minutes. Surprisingly, microbial uptake was much faster than the physicochemical sorption (estimated in sterilized soil), which needed 60 minutes to reach quasi-equilibrium for alanine and about 400 minutes for glucose. Only acetate sorption was instantaneous. At a concentration of 100 μm , microbial decomposition after 4.5 hours was greater for alanine ($76.7 \pm 1.1\%$) than for acetate ($55.2 \pm 0.9\%$) or glucose ($28.5 \pm 1.5\%$). In contrast, incorporation into microbial biomass was greater for glucose ($59.8 \pm 1.2\%$) than for acetate ($23.4 \pm 5.9\%$) or alanine ($5.2 \pm 2.8\%$). Between 10 and 500 μm , the pathways of the three LMWOS changed: at 500 μm , alanine and acetate were less mineralized and more was incorporated into microbial biomass than at 10 μm , while glucose incorporation decreased.

Despite the fact that the LMWOS concentrations in soil solution were important for competition between sorption and microbial uptake, their fate in soil is mainly determined by microbial uptake and further microbial transformations. For these substances, which represent the three main groups of LMWOS in soil, the microbial uptake out-competes sorption.

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Effect of soil type on extracellular enzyme activity and nutrient dynamics in two halophilous grasslands in northern Mexico

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Nutrient availability in ecosystems depends on depolymerization of organic matter (OM) and on the subsequent mineralization of the generated products. Enzymes associated with transformations of OM are essential for maintaining vital processes of ecosystems. Such enzymatic transformations take place in an environment formed by a complex matrix of sand, silt and clay particles intermixed with organic substances, mainly derived from the vegetation. In order to convert this organic complex into energy and nutrients essential for the biota, microbial communities must produce extracellular enzymes that produce compounds having the appropriate size for being incorporated inside cells, where they are metabolized. Among factors of the extracellular environment affecting the activity of such enzymes are temperature, humidity, pH, OM incorporation and interactions with clays. The objective of the present work was to analyze the effect of soil type on nutrient dynamics and on the activity of five enzymes involved in C and P availability in two grasslands (Churince and Pozas Azules) in northern Mexico dominated by the grass *Sporobolus airoides* (Poaceae). Two types of alkaline soil are dominant in the valley: Gypsisol in Churince, rich in CaSO₄; and Calcisol in Pozas Azules, rich in CaCO₃. In both sites ten composite soil samples were taken in a 500 m² area that were used for biogeochemical analysis and for the determination of cellobiohydrolase, β-glucosidase, polyphenol oxidase, β-N-acetylglucosaminidase and phosphatase activity. The grassland in Churince showed more availability of C and P, higher humidity content and a lower pH value. The enzymatic activity of polyphenol oxidase, associated with lignin degradation, was higher in Churince, and that of glucosidase, associated with cellulose degradation, was higher in Pozas Azules. The activity of the remaining analyzed enzymes did not show significant differences between studied sites. Given that in both sites the main input of organic matter comes from the same grass species (*S. airoides*), containing a larger proportion of lignin than of cellulose, the data suggest that activity of polyphenol oxidase is determinant for C availability and that, in the physicochemical conditions of the soil in Churince, either larger amounts of the enzyme are produced, or this is more active. The present work represents a contribution to the knowledge of nutrient dynamics in grasslands on alkaline soils, of which few studies exist.

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Session 5

Organo-mineral interactions in soils

Iron oxide removal and copper sorption on a Luvisol argic horizon

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Copper enter to the soil in toxic concentration during fungicide application and other environmental pollution. Iron oxides and swelling clay minerals are important heavy metal binding components due to their high surface area and surface charge. Adsorption experiments combined with selective iron oxide extractions provide an effective tool to compare the adsorption properties of these metal binding minerals and to evaluate the role of clay mineral and iron oxide associations in soil sorption processes.

In this work copper sorption was carried out before and after oxalate (Feo) and dithionite soluble iron (Fed) removal on a soil B horizon characterized by clay and iron accumulation. Experiment conditions were slightly acidic pH and low CaCl₂ ionic strength solution. Mineralogical changes during the extraction and sorption experiments were studied by X-ray diffraction and thermal analysis.

The clay mineral character is defined by hydroxi-interlayered vermiculite in A, E, mixed layer chlorite/vermiculite in B and chlorite and illite in C horizon. The most trace elements (Ce, Co, Ga, Ni, Pb, Rb, Sc) follow the distribution of the iron oxides and the swelling clay minerals.

Ammonium oxalate and sodium dithionite treatments had no significant effect on a bulk soil adsorption capacity calculated by Langmuir equation. However, in the clay fraction the amount of adsorbed copper after the removal of Fed decreased by two third. Because of the much lower amount of Feo relative to Fed, maximal adsorption capacity has reduced by one quarter after oxalate treatment. According to XRD data the basal spacing of the copper-treated clays has not changed (14,3 Å), but the high concentration (1000 ppm) of heavy metal reduced the swelling capacity of the vermiculite. In contrast the ammonium oxalate and sodium dithionite/copper treated clay fractions kept their original expansion ability. Based on thermal analysis results interlayer water loss of copper sorbed vermiculite was moderate compared to Mg-vermiculite.

Our copper adsorption and iron extraction study on an argic horizon denote an important role of iron oxides in heavy metal adsorption. Furthermore, immobilized copper affect soil hydraulic conductivity due the change of clay mineral expanding properties.

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Organic acids exuded from two aluminium tolerant wheat cultivars in short and long term by hydroponic systems with increasing aluminium levels

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Some wheat genotypes in southern Chile are very Al tolerant, being capable of growing in acidic soils with up to 70% Al saturation. External Al detoxification may be one of the most widely mechanism used by tolerant plants through exudation of organic acids from the root apex reducing Al³⁺ activity in the rhizosphere. The aim of this study was to analyze the exudation of organic acids from two Al tolerant native wheat cultivars (Crac and Porfiado) growing at increasing Al levels in hydroponic systems. Both cultivars were grown in nutrient solution pH 4,5 for 21 days. Plants were exposed to five Al levels - 0, 100, 200, 400 and 800 μM (AlCl₃) and pH was adjusted daily. Organic acids were collected under constant aeration during one hour in deionized water and analyzed by ion chromatography on a Dionex ICE-AS6 column (Dionex Corp., Sunnydale, CA). Dry weight and root elongation were measured in 3 times, T0 after 21 days of growth, T1 and T2 after 2 and 7 days exposed to Al respectively. Organic acid and relative amount of chlorophyll were analyzed in short and long term (2 and 7 days). The Crac cultivar showed higher shoot and root dry weight and root elongation at higher Al levels. In addition, the Crac cultivar did not decrease in chlorophyll content until 800 μM Al in T1 and T2. Malic acid was secreted at higher Al levels in both cultivars and in the short term reaching to 11 $\mu\text{mol g}^{-1} \text{h}^{-1}$ in Porfiado cultivar in 800 μM Al and 8.4 $\mu\text{mol g}^{-1} \text{h}^{-1}$ in Crac cultivar when it was exposed to 400 μM Al in T1. Lactic, formic and acetic acids were secreted in both cultivars and mostly when it was exposed to lower Al concentrations. The Crac cultivar secreted 27 and 4 $\mu\text{mol g}^{-1} \text{h}^{-1}$ of lactic acid at 100 and 800 μM Al respectively at T1. Formic acid was secreted in higher quantities in Crac, exuding 86 and 65 $\mu\text{mol g}^{-1} \text{h}^{-1}$, in 0 and 100 μM respectively at T1. The same trend was shown with acetic acid at both times. Showing a greater tolerance at higher Al concentration. Malic acid exudation should be an important mechanism for Al tolerance in these wheat cultivars, showing increased exudation at higher Al levels. It appears that the exudation of other organic acids such as acetic formic and lactic and formic acids show a decrease as Al concentrations increase.

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Influence of the soil type and soil management in the soil quality and soil ultramicrofabric in olive crops from Sierra Mágina, Jaén

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The estimation of soil quality is a tool to assess the effects of the use and management on soil, and environmental management for maintenance of natural resources. In an agricultural context, soil quality can be engineered to maximize production in the framework of minimal environmental impact.

We have studied the quality parameters of five soils in the province of Jaén (Spain) in the region of Sierra Mágina: four of them are dedicated to the cultivation of olive tree (the province of Jaén is the leading world producer of olive oil) and the fifth is a reference natural soil (Haplic Cambisol).

Of the four agricultural soils, both have organic management (one Calcaric Eutric Regosol developed on marl and Cutanic Cromic Luvisol on limestone debris management) (a Calcaric eutric Regosol developed on marl and Cutanic Cromic Luvisol on limestone debris) and others two are conventional management (a Calcariceutric Regosol developed on marl and Cromic Cutanic Luvisol on limestone debris).

From the results we can deduce that soils under organic tillage are those with higher quality (compared to natural soil and conventional management), and is especially favorable Cromic Cutanic Luvisol on limestone debris and organic management.

With regard to the quality of the parameter structure, soil Cromic Cutanic Luvisols developed on limestone debris are those that maintain a higher quality compared to Haplic Cambisol natural soil selected as reference and Calcaric Eutric Regosols on marl. From this it follows: 1) the soil quality olive Sierra Mágina is strongly influenced by the rock-forming factor, though clearly marked trends influenced by improved organic management, despite the short time of crop implantation (18 years), and 2) the natural soil has poor quality that organic soil organic management on debris.

Also was described by SEM the different hierarchically of the soil aggregates of the conventional and organic soil uses. In the aggregate soil particles was defined the ultramicrofabric, the particle clusters and the particle domain. In the microaggregate were interpreted three images: one of the general microaggregate in 500 micras and others two of the intermicropeds area and the micropeds surface area, both in 20 micras.

We could conclude that the organic ecological management of these soils improves their quality and, therefore, would ensure sustainable agricultural production in the study area. In addition, proper management of conversion from conventional...

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Synthesis and characterization of spermine-exchanged montmorillonite and its complexes with the herbicide fluometuron

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Different organic cations have been used to modify smectitic clay minerals to get organoclays with high affinity for organic pollutants such as pesticides. The use of natural organic cations for this purpose has recently gained increased interest, to minimize the impact of the organoclay once incorporated into environmental compartments.

In previous work, we found that modification of SWy-2 Wyoming montmorillonite (SW) with the naturally-occurring organic polycation spermine (SPERM) led to organoclays (SW-SPERM) with very high affinity for phenylurea herbicides, such as fluometuron. Here, we used X-ray diffraction (XRD), Fourier-transform infrared spectroscopy (FT-IR), and thermogravimetric analysis (TGA) techniques to get further insight into i) the interaction mechanisms between the spermine cation and the montmorillonite (SWy-2) surface and ii) the interactions of the organoclay (SW-SPERM) with the herbicide fluometuron. SW-SPERM self-supported clay films (SSCFs) were prepared and used for XRD, FTIR and TGA analysis. Changes in XRD, FT-IR, and TGA patterns as a function of the amount of spermine incorporated into the clay and of the amount of fluometuron adsorbed on SW-SPERM were determined.

Spermine incorporated stoichiometrically into SWy-2 up to the CEC of the clay, resulting in interlayer SW-SPERM complexes with d001-spacings of about 13.0 Å that displayed greater resistance to expansion upon hydration than the original Na-saturated clay. These results indicated the arrangement of spermine cations forming a hydrophobic horizontal monolayer within the clay mineral interlayers and very strong ionic and hydrophobic spermine-clay layer interactions. TGA analysis indicated that intercalation of spermine into SWy-2 led to an increase in the thermal stability of the organic cation. FT-IR measurements of SW-SPERM samples showed the intensity of the spermine -N-H and C-H deformation vibrations increased linearly with the amount of spermine incorporated into SWy-2. The FT-IR study was also conducted using in situ attenuated total reflectance (ATR-FTIR) and confirmed the interaction of spermine with the clay and that the maximum amount of spermine intercalated was close to the CEC of SWy-2. Characterization of SW-SPERM-Fluometuron systems confirmed the high affinity of the herbicide for the organoclay and revealed possible functional groups involved in the interaction.

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Sorption of acidic organic solute onto kaolinitic soils from methanol-water mixtures

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Sorption of naphthalene (NAP) and 1-naphthoic acid (1-NAPA) by three kaolinitic soils and two model sorbents (kaolinite and humic acid) were measured as functions of the methanol volume fractions ($f_c \leq 0.4$) and ionic compositions (CaCl₂ and KCl). Solubility of 1-NAPA was also measured from various ionic compositions. Sorption data were interpreted using the cosolvency-induced sorption model. K_m (=the linear sorption coefficient) of NAP for kaolinitic soil for both ionic compositions was log linearly decreased with f_c . However, K_m of 1-NAPA for both ionic compositions remained relatively constant over the f_c range. For the model sorbent, K_m values of 1-NAPA by kaolinite for the KCl system and by humic acid for both ionic compositions decreased with f_c , while 1-NAPA sorption by kaolinite for the CaCl₂ system was enhanced with f_c . From the solubility data of 1-NAPA with f_c , no significant difference was observed from the different ionic compositions, indicating an insignificant change in the aqueous activity of the liquid phase. In conclusion, enhanced 1-NAPA sorption greater than predicted from cosolvency-induced model is due to untractable interaction between carboxylate and hydrophilic soil domain from methanol-water system.

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Sorption Characteristics of the Major Components of Crude Oil to Vadose Zone Soils in Xinjiang Oilfield

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With the substantial increase in the amount of oil production, the problem of soil and groundwater contamination is more and more serious. Benzene, toluene, ethylbenzene, xylenes, 1,3,5-trimethylbenzene, naphthalene, etc. these volatile organic compounds (VOCs) are main dissolved pollutants of landed crude oil and productive water in oilfield. In order to evaluate the vulnerability of vadose zone to crude oil pollution, single component and mix components sorption batch experiments were conducted to analyze the sorption characteristics of Xinjiang oilfield soils to crude oil pollutants of benzene, toluene, ethylbenzene, xylenes, 1,3,5-trimethylbenzene and naphthalene these eight compounds. The results showed that the sorption equilibrium isotherms of single component and mix components to the soils used in the experiment were both linear. The partition coefficients K_d for the eight single and mix components of benzene, toluene, ethylbenzene, o-xylene, m-xylene, p-xylene, 1,3,5-trimethylbenzene and naphthalene were 2.64, 1.19, 3.52, 1.10, 2.99, 1.30, 3.58, 1.74 and 2.16, 0.95, 0.71, 0.86, 0.63 (for m+o-xylene), 0.73, 0.49, respectively. The smaller values in the mix components sorption experiment suggesting that competitive sorption phenomenon exists and the sorption mechanism for different compounds in a mixture solution is not just a partitioning but a complex sorption process due to the change of soil properties. Besides, all the distribution coefficient values were not great indicating that sorption capacity of crude oil pollutants to the vadose zone soils in Xinjiang oilfield is limited. As a result, the crude oil spilled onto the oilfield contaminates not only the vadose zone but also the groundwater through the precipitation.

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Chemical extractions of the mineral-associated SOM: an integrated approach for a functional fractionation

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The interaction between organic substances and mineral components in soils is a way of soil organic matter (SOM) stabilization, probably more relevant than the humification process itself. This interaction may occur through a wide range of mechanisms: weak electrostatic unions, precipitation by cations (Ca, Fe, Al), hydrogen bonds, association with iron and aluminum oxides, occlusion by fine carbonate layers... By using the appropriated reagents, it is possible to extract from soil the organic compounds stabilized by a specific type of liaison. However, in order to gain a compelling insight about the mineral stabilization of SOM, it would be desirable to have a complete protocole, capable of distinguishing several organic fractions according to their kind of mineral association, and to quantify them.

Our proposal involves a two-step procedure. Firstly, the soil sample is subjected to physical fractionation, in order to separate the particulate organic matter (POM; > 20 µm) from the organomineral complexes. Whereas POM is assumed to account for the free organic debris, not (or very weakly) associated to the mineral components, the organomineral fraction (< 20 µm) is subjected to a sequential set of extractions: (1) with a weak K₂SO₄ solution, to extract residual water-soluble compounds; (2) with Na-tetraborate (« Borax »), which gathers those organic molecules essentially adsorbed by electrostatic bonds to mineral surfaces; (3) with Na-pyrophosphate, a chelating agent that solubilizes organic compounds precipitated by calcium, iron or aluminum cations; (4) and with NaOH, for a massive extraction. (5) The residue is treated with cold, weak acid, to destroy carbonates, and again with NaOH to extract organic compounds occluded by carbonates. (6) The residue is treated with dithionite, to reduce Fe and Al oxides and hydroxides, so making soluble the compounds stabilized by them, and again extracted with NaOH. (7) To solubilize the fraction associated to clay by bonds strong enough to resist the previous treatments, the residue is treated with HF, then extracted again with NaOH.

The usefulness of the applied extractants is already known. The challenge herein is to put all them in the appropriate order in a sound sequence. Rather than studying a single and specific fraction, we aim to achieve a panoramic, complete view of how – and to what extent – the SOM of a given soil horizon is stabilized by its mineral components.

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Effects of flooding and drying on the solubility of soil nutrients evaluated at watershed and regional scales

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In rain-fed paddy ecosystems, topsoil is often subjected to alternate flooding and drying, which can affect the solubility of soil nutrients. However, most studies focused on a particular element, soil type and observation scale. We aimed to evaluate the effects of flooding and drying on the solubility of nitrogen, phosphorus and potassium in soils sampled at watershed and regional scales.

Eighteen surface soils (11 from Thailand, 6 from Japan, 1 from China) were used, eight of which from Thailand were rain-fed paddy soils located in the same watershed with different elevation. The soils were incubated anaerobically at 30°C for 28 days with or without subsequent air-drying. Then the soils were extracted sequentially with 0.01M CaCl₂ and a Bray no. 2 solution. Ammonium, inorganic P and K in CaCl₂ extracts, and inorganic P and Fe in Bray no. 2 extracts were determined.

At the watershed scale, the concentrations of NH₄⁺ and K in CaCl₂ extracts increased after the incubation. The increases corresponded with the contents of soil organic matter and clay, suggesting that net mineralization of organic matter affected their increases. The concentration of inorganic P in CaCl₂ extracts decreased and that of inorganic P in Bray no. 2 extracts increased after the incubation. The increases of inorganic P in Bray no. 2 extracts corresponded with the contents of soil organic matter and Bray no. 2-extractable Fe except for a low P soil located at the lowest elevation. This suggested that reduction of Fe-bound P was responsible for the increase of Bray no. 2-extractable P for most soils. After the wet-dry cycle, the concentrations of NH₄⁺ and K in CaCl₂ extracts and that of inorganic P in Bray no. 2 extracts increased for all soils.

At the regional scale containing soils with various parent materials, the concentrations of NH₄⁺ and K in CaCl₂ extracts decreased for some soils. The concentration of Bray no. 2-extractable P in two soils classified as an Andosol and an Acrisol decreased significantly after the incubation. This could not be explained by the release of Bray no. 2-extractable Fe during the incubation. After the wet-dry cycle, the solubility of nutrients increased for K but not necessarily for N and P.

In summary, the effects of flooding and drying on the solubility of soil nutrients were affected mainly by a clay-organic matter complex and soil parent materials, resulting in contradictory results between watershed and regional scales.

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Use of soil micromorphological studies to explain some soil characteristic changes by rye green manure application

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Soil micromorphological properties were studied to explain the trend of green manure decomposition in soil and its effect on soil structure stability and soil infiltration rate. Long term study was carried out with or without rye green manure along with 4 nitrogen fertilization treatments (0, 26, 103 and 337 (kg N/ha) in 3 rotation system (green manure-wheat) in maragheh-iran dry land condition. The results showed never eless changes in soil aggregate stability and water infiltration, these characteristics variation could not interprets by usual soil physical and chemical analyses (such organic matter content or bulk density) whereas were easily clarify by soil micromorpholocial investigations.

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The binding of selected monosaccharides to ferrihydrite by adsorption and coprecipitation- investigated by desorption experiments, infrared spectroscopy (FTIR) and N₂ gas adsorption measurements

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Recent studies on adsorption and coprecipitation of natural organic matter (water extract of a Podzol forest-floor layer) with ferrihydrite resulted in the preferential binding of polysaccharides to the mineral. This fractionation was accompanied by a further fractionation of the individual sugar monomers. While e.g. glucose was selectively enriched in the ferrihydrite-associated organic matter, galactose was depleted. Such a fractionation will affect composition and storage of polysaccharides in soil. In current experiments, we are therefore investigating the sorption behaviour of synthetic monosaccharides to ferrihydrite to understand the underlying sorption mechanisms.

We produce organic matter-ferrihydrite associations by adsorption and coprecipitation with glucose, galactose and glucuronic acid at pH 5 and investigate the solid products by Fourier transform infrared spectroscopy (FTIR) and N₂-gas adsorption. Strength and reversibility of the bonds between monosaccharides and ferrihydrite will be investigated by desorption experiments. A more precise knowledge on the sorption mechanisms will be gained by FTIR. The surface area of the ferrihydrite will be determined by N₂ gas adsorption measurements: since ferrihydrite exhibits large N₂-gas adsorption-surfaces (~300 m² g⁻¹), but organic matter has only small ones (~1 m² g⁻¹), we will be able to estimate the surface coverage of the monosaccharides at different organic matter loadings. We hypothesize that glucose and galactose will desorb relatively easy because of the formation of rather weak hydrogen bonds. If we observed different sorption affinities of these two monosaccharides, we would have to consider steric reasons. In contrast, the carboxyl group of the glucuronic acid may form stronger inner sphere as well as outer sphere complexes with the hydroxyl group of the mineral.

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Interaction of selected minerals with organic pollutants: Effects of Phyto-assisted Bioremediation using *Vigna subterranea*

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Soils contaminated with hydrocarbons are a serious problem in Nigeria and 70% of such soils are distributed in the Niger Delta. This pot experiment was conducted to determine the interactions of selected soil minerals with organic contaminants from oil spill site. *V. subterranea*, which potential for stimulating the biodegradation processes of petroleum hydrocarbons was established was employed under the application of two fertilizer types. Iron concentrations were greater than maximum permissible levels, MPL for plants grown in contaminated soil and showed significant variation ($p < 0.05$) compared to control. Poor zinc concentrations in oil –stressed regimes decreases ear size, slowed growth and maturity of specie. Both iron and manganese became less available at $pH > 7$ in the absence of organic matter and water (dehydrated due to oil – stress). Concentration of available P was sensitive to soil pH and was more available to Poultry manure – amended soil as pH correction was evident. Plant tissue analyses revealed significantly ($p \leq 0.05$) higher increases in accumulation, in comparison with those grown in unpolluted (Control) regimes. Also, soils depleted mineral nutrients were replenished ($> 30\%$) by test plant and best practice.

These results indicated that soil minerals affect the dynamics and transformations of organic materials and metabolic processes even in a stressed soil type with modifications due to clean-up.

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Adsorption and oxidative transformation of phenolic acids by Fe(III)-montmorillonite

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Phenolic acids participate in various soil processes and are of great concern due to their allelopathic activity. The interactions of phenolic acids (ferulic, p-coumaric, syringic, and vanillic) with montmorillonite enriched with Fe(III) was investigated. Adsorption of the phenolic acids on Fe(III)-montmorillonite was accompanied by their oxidative transformation and formation of Fe(II). Oxidative transformation of phenolic acids was affected by their molecular structure. The order of maximal transformation at the initial acid concentration of 20 mg/L on the surface of Fe(III)-montmorillonite was: ferulic (94%), syringic (60%), p-coumaric (35%) and vanillic (25%). Benzoic acid which was used as a reference aromatic compound exhibited only 5% transformation. Removal of the phenolic acids from solution increased with decreasing pH. LC-MS analysis demonstrated the presence of dimers, trimers, and tetramers of ferulic acid on the surface of Fe(III)-montmorillonite. Oxidation and transformation of ferulic acid were more intense on the surface of Fe(III)-montmorillonite as compared to Fe(III) in solution due to stronger complexation on the clay surface. The results of the current study demonstrate the importance of Fe(III)-clay surfaces for the abiotic formation of humic materials and for the transformation of aromatic (phenolic) pollutants.

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Adsorption of humic acid on hematite: effects of pH and ionic strength

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Static experiments were conducted to investigate adsorption of humic acid (HA) on hematite. The point of zero charge (PZC) and specific surface area of hematite was 9.17 ± 0.25 and 5.22 ± 0.04 m² g⁻¹, respectively. The contents of total acidity, COOH and phenolic OH of HA were 5.84 ± 0.37 , 2.47 ± 0.04 and 3.37 ± 0.41 mmol g⁻¹. HA concentration of samples were quantified by total organic carbon (TOC) analyzer, and molecular weight (MW) of HA were estimated through E2/E3 (the ratio of absorbance at 250 nm (E2) and 365 nm (E3)) of HA solution measured by UV spectrophotometer.

HA adsorption on hematite was strongly dependent on pH. Lower pH was beneficial to adsorption, which was also consistent with Fourier transform infrared spectroscopy (FTIR) results. With increasing pH, the adsorptive HA declined slightly from 12.9 mg C g⁻¹ to 12.5 mg C g⁻¹ at pH < 8.5, and then decreased to 5.4 mg C g⁻¹ very fast above PZC of hematite. The dramatic change in HA adsorption at pH around PZC illustrated different interactions occurred at lower and higher pH. On the other hand, certain amount of HA still adsorbed at pH > PZC indicated that other mechanisms such as hydrophobic interaction, hydrogen bonding and specific adsorption should involve besides electrostatic interaction. Increase in E2/E3 of HA solution indicated that higher MW fractions of HA were relatively preferentially adsorbed on hematite at pH < 9, but no significant change in E2/E3 at higher pH also implied that other interactions involved.

Maximum adsorption of HA on hematite increased rapidly with increasing salt concentration due to the decrease of electrostatic attraction among HA molecules. The adsorption of HA on hematite was supposed to be monolayer adsorption due to (1) interactions between HA and surface hydroxyl of hematite occurring on hematite surface and (2) negative hematite surface with adsorbed HA restraining further HA adsorption in solution. The priority of higher MW components of HA adsorbed were reasonably explained by electrostatic and hydrophobic interactions during adsorption process, especially at higher ionic strength solutions.

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Adsorption of prion protein on organo-mineral complexes and Scottish soils

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Prion proteins, generally considered to be the infectious agent of transmissible spongiform encephalopathies (TSEs), are pathogenic proteins that could be released into soil environment by the excretion of diseased animals and the decomposition of infected carcasses. These pathogenic proteins are strongly resistant to a variety of conditions that inactivate conventional pathogens, and their infectivity can be kept for many years in soil where prion proteins can be adsorbed by soil components. The adsorption process could protect prion proteins from in situ proteolysis and also alter their conformation by changing their infectivity. Therefore, clear understanding on the fate of prion proteins in soil environment could facilitate the evaluation and control of ecological safety.

In the current study, we observed the adsorption behavior of a recombinant prion protein (recPrP) on some synthetic organo-mineral complexes, formed by mutual interaction of montmorillonite, OH-Al species and organic ligands (gallic acid, tannic acid), and on Scottish soils with different texture (clay soil and sandy soil), collected at different depth (top soil and sub soil) and treated or not with H₂O₂ to remove organic matter. The results showed that the adsorption of recPrP on organo-mineral complexes increased with the increase of CEC and organic ligand content of organo-mineral complexes. These latter with gallate and tannate showed, respectively, lower and higher CEC than Na-montmorillonite. On Scottish soils the adsorption of recPrP was greater on clay and top soils than on sandy and sub soils, likely due to the greater organic C content in the former soils. Furthermore, the recPrP adsorption on each soil sample was reduced after the removal of organic matter by H₂O₂, confirming the importance of organic matter in the adsorption of recPrP in according to the behavior of organo-mineral complexes. These results are of foundational significance for evaluating the fate of proteins in soils.

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Influence of lysozyme complexation with humic acid on the lysozyme activity

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In the natural environment of aqueous solutions and soil solutions proteins can form complexes with the natural dissolved organic matter. Humic acid is an important component of the dissolved organic matter and in two previous papers it has been shown that purified Aldrich humic acid (PAHA) forms strong complexes with the protein lysozyme (LSZ). For enzymes the complex and aggregation with humic acid may lead to changes in the enzyme activity. Therefore, the enzyme activity of LSZ in the PAHA-LSZ complex as a function of mass ratio PAHA/LSZ was investigated at two pH values and two salt concentrations. The newly prepared PAHA sample was characterized and the mass ratios PAHA/LSZ at IEP of the complex at the different conditions were obtained with the Müttek particle charge detector. The LSZ activity was measured with an assay specific for LSZ. The activity of LSZ decreased upon complex with PAHA and the effect on the enzyme activity increased by the subsequent aggregation. A critical PAHA/LSZ mass ratio for the behavior of the enzyme activity was that at the IEP of the complex. Before this mass ratio was reached the LSZ activity strongly decreased under all conditions. Beyond this mass ratio both pH and ionic strength affected the activity of LSZ in the complex. At low ionic strength (5 mmol L⁻¹) there was an upward trend of LSZ activity after the first decreasing stage followed by a gradual decrease, while only a gradually decreasing activity was observed at 50 mmol L⁻¹ ionic strength. The pH had a significant effect on the LSZ activity in the complex only at 5 mmol L⁻¹. The enhancement of the activity at pH 5 was larger than at pH 8, and the residual activity at a mass ratio of 2.0 was also larger at pH 5 than at pH 8. The interaction between PAHA and LSZ was due to mutual complex of the functional groups of both components and the electrostatic attraction between the negative PAHA and the positive LSZ, but around the IEP of the complex hydrophobic attraction and counterion release were also contributing.

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Study of acid phosphatase immobilization mechanism in nanoclay using confocal microscopy

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In the recent year the enzyme immobilization has been seen an effective approach in the development of technologies. Phosphatase enzymes have been immobilized in various clay minerals and their catalytic activity and stability depends on the type of immobilization and the nature of the support. The enzyme immobilization of enzymes can be obtained through two mechanisms i) chemical bonding (adsorption) and ii) physical restraint (microencapsulation). Furthermore, results of enzyme immobilization by physical restraints in materials with a high surface area have shown that in this type of support, enzymes have a higher catalytic activity and efficiency than the free enzyme. The aim of this study was to evaluate the mechanism of acid phosphatase immobilization in microaggregates of nanoclay using confocal microscopy. Natural allophane extracted from a Chilean andisol containing around 28 % of C was used as a support material. The results of confocal analysis of free phosphatase showed autofluorescence mainly at 520 nm, whereas allophane - phosphatase complex emitted autofluorescence at 461 nm, 520 nm and 572 nm. Because of an overlap in the autofluorescence of the sample it was not possible to identify the complex. Natural allophane with organic matter presented autofluorescence in same wavelength but without organic matter (1.3 % OM) showed a weak autofluorescence signals. These results indicated that organic matter interferes in the analysis of the complex. To further elucidate the mechanism of the phosphatase immobilized in this type of support a synthetic allophane and montmorillonite nanoclay without organic matter were used. The results showed that synthetic allophane in acetate buffer do not emit autofluorescence, whereas the acid phosphatase - synthetic allophane complex showed an autofluorescence mainly at 520 nm. The phosphatase autofluorescence was located within microaggregates of allophane, suggesting that the phosphatase is immobilized by encapsulation. Similar pattern was obtained with acid phosphatase - montmorillonite nanoclay. To assess whether the phosphatase was encapsulated within aggregates of montmorillonite a 3D projection was modeled, the images of a cross-sectional area showed that fluorescence corresponding to phosphatase occluded in the microaggregates of montmorillonite, observed higher intensity points within the structure. We can conclude that acid phosphatase is immobilized in natural nanomaterials mainly by encapsulation...

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Hydroxy- and fluorapatite as sorbents in Cd(II) - Zn(II) multicomponent solution in the presence of EDTA

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The removal of heavy metals from contaminated waters and soils needs a special attention because their variety of toxic effects to human and ecological health. Among different treatments the adsorption technology is attractive due to its efficiency, economy and simple operation. Hydroxyapatite (HAP- $\text{Ca}_{10}(\text{PO}_4)_6(\text{OH})_2$) and fluorapatite (FAP- $\text{Ca}_{10}(\text{PO}_4)_6(\text{F})_2$) are approved and recommended as an effective metal ions binding materials.

The binding process on apatite (AP) is controlled by number of factors including pH, contact time, type of metal ions in a solution, AP physico-chemical properties, etc. The fixation of metal ion on AP surface may take place through one or more simultaneous mechanisms of: ion exchange, surface complexation, precipitation and coprecipitation. In soils and natural waters metal ions complexation by organic ligands and competing sorbates must be considered as well.

The removal of Cd and Zn from single- and multi-metal aqueous solutions by apatites was investigated with and without EDTA being present. Batch experiments were carried out using synthetic hydroxy- and fluorapatite with Ca/P 1.60 and 1.68, a specific surface area of 40.2 m²/g and 38.9 m²/g resp. in the pH range 4 to 9 (25°C; 0.1 M KNO₃). The initial concentrations of Cd²⁺, Zn²⁺ and of EDTA were 0.002 M. The solid-solution ratio was 2 g/L. Equilibration time was 7 days. The surface composition of solid phases was analysed by X-Ray Photoelectron Spectroscopy (XPS).

The amount of Cd²⁺ and Zn²⁺ removed from the solution increased with increasing pH with both apatites. In a binary solution below pH 8 the competition of metals reduced the individual sorption amount of 10-14 % compared with the single component solutions. The total adsorption maximum on AP-s before the precipitation of hydroxides (pH>8) was approximately 0.8 ± 0.1 mM/g. The presence of EDTA reduced the amount of sorbed metal because of the formation of [CdEDTA]²⁻ and [ZnEDTA]²⁻ in solution. In a Cd-Zn-EDTA-solution the amount of sorbed Zn²⁺ did not change remarkably due to the stronger [CdEDTA]²⁻ complex in comparison with [ZnEDTA]²⁻ and [CaEDTA]²⁻ complexes. In any case the sorbed amount of Zn²⁺ was higher compared with Cd²⁺ and was less affected by the solution composition.

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Clay mineralogy of soils derived from different granitoides in a temperate climate of Sudety Mountains, Poland

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Soil profiles developed from different granitoides (leucogranite, granite, granodiorite and tonalite) were investigated. The soil profiles were located in the Fore-Sudetic Block and the Sudetes, Lower Silesia, Poland. To investigate only relationships between clay mineral and parent rock composition, and to avoid the effects of other soil-forming factors, the profiles were located only on the top parts of hills of elevation 169 – 433 m a.s.l. and in similar climatic conditions, including rainfall 600-750 mm and annual average temperature 7.0 – 8.5 oC. The investigated soils are forest and meadow leptosols. Two samples were collected from each profile (the A horizons and the parent rock horizons) to determine the possible variation in the composition of clay minerals within the profile.

The study of clay minerals showed that colloidal fraction of soil material – although developed from different granitoides, build up of different feldspars and plagioclases and different amounts of mafic minerals – consists of different amounts of illite, kaolinite and vermiculite. These minerals are present in all of the examined profiles, but illite distinctly dominates in soils derived from leucogranite, granite and granodiorite, whereas vermiculite is the main clay mineral in tonalite derived soils, independently of the depth of the soil horizon. On the other hand, soils derived from leucogranite, granite and granodiorite reveal presence of vermiculite in the deeper horizons, while A horizons indicates significant decrease or lack of this mineral. This may suggest the process of transformation of vermiculite into illite, occurring over the time under conditions of temperate climate of Lower Silesia, SW Poland.

There were also differences in clay mineralogical composition between deeper horizons of soils derived from different kinds of granites. Vermiculite was observed in soil material derived from biotite-granite, while there were found only very weak evidence of this mineral in weathered material of two-micas-granite. This confirms that the presence of biotite in rock favours formation of vermiculite during the weathering processes.

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Influence of montmorillonite on the catalytic activity of chymotrypsin: effect of enzyme and substrate adsorption

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In soils, microorganisms are responsible for an important part of the biodegradation which improves the availability of the major elements necessary for biological activity. Microorganisms must secrete extracellular enzymes to split polymers into an assimilable form.

Adsorption of extracellular enzymes and the biodegradation of protein substrates are influenced by their adsorption on mineral surfaces.

The catalytic activity of a protease (bovine pancreas α chymotrypsin) in the presence of a clay mineral (homoionic Na-montmorillonite) has been studied.

We have investigated the importance of various parameters in the clay effect on the enzymatic activity : pH, ionic strength, enzyme and substrate adsorption, order of reagents addition. This lead us to specify how the interactions between mineral and organic matter affect the extracellular enzyme activity in soils.

Two substrates have been used : (i) benzoyl tyrosyl-nitro-anilide (BTNA, MW 400) which is not adsorbed on clay surface, and (ii) a protein (casein, MW 25000).

In all conditions with clay, we determined the activities and fractions of free and adsorbed enzyme and the fractions of free and adsorbed substrate when casein is used.

In such enzymatic systems with clay, there are four possible enzymatic complexes : free enzyme with free substrate ($E_{\text{free}}-S_{\text{free}}$), free enzyme with adsorbed substrate ($E_{\text{free}}-S_{\text{ads}}$), adsorbed enzyme with free substrate ($E_{\text{ads}}-S_{\text{free}}$) and adsorbed enzyme with adsorbed substrate ($E_{\text{ads}}-S_{\text{ads}}$). We tried to quantify the influence of each inhibiting factor of the catalytic activity with clay. Compared to the activity of free enzyme with free substrate, coefficients R traduce the effect of the clay on the adsorbed enzyme (R_1), on the adsorbed substrate (R_2), on the complex (adsorbed enzyme- adsorbed substrate) (R_3).

Our results show that extracellular enzymes activities in soils are not only influenced by their adsorption on mineral surfaces and physico-chemical parameters such as pH and ionic strength. They are also dependent on the location of the organic matter. Clay-organic matter complexes modify the adsorption and the activity of extracellular enzymes. When organic matter acts as substrate of the enzyme reaction, its free or adsorbed status is also very important. .

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Phytase interaction with allophane and iron oxide coated allophane nanoclays

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The temperature effect on the activity microbial phytases (*A. niger* and *E. coli*) sorbed on synthetic allophane nanoclay compounds was evaluated. Allophane and synthetic iron-coated allophane (2% and 6% of Fe) were used as solid supports. The maximum temperature of activity, temperature coefficient (Q10), activation energy (Ea) and activation enthalpy (ΔH^\ddagger) were measured to free and immobilized phytases. The activity-temperature dependence curves showed strong variations between free and immobilized phytases. With the exception of *E. coli* phytases immobilized on montmorillonite, phytases immobilized on nanoclay showed the highest optimal temperatures, therefore exhibiting the highest resistance to thermal denaturation. The Q10 values increased by immobilization for both enzymes, and were around 2–3 per each 10 °C, as expected. The increase of Q10 values for the immobilized phytases suggests that the heterogeneous catalysis system may be positively affecting phytate dephosphorylation. Both Ea and ΔH^\ddagger were estimated using Arrhenius plots of the log linear interval of activity-temperature dependency curves. Immobilization of the phytases resulted in higher Ea and ΔH^\ddagger values compared with the free enzymes. The increase of Ea and ΔH^\ddagger values after immobilization indicated a modification of the reaction mechanisms either by a less favorable location of the phytases on the supports, or due to the presence of diffusion restrictions of substrate and products. Iron oxide coating of allophane progressively decreased Ea and ΔH^\ddagger values for the immobilized phytases compared with the immobilized phytases on uncoated allophanes, suggesting a better arrangement of phytase enzymes on the nanoclay surface due to changes nanoclay surface properties.

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Effect of oxalic and citric acid on adsorption of copper and cadmium onto vermiculite, kaolinite and goethite.

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Mineral cations from soil solution can adsorb to the negatively charged colloidal fraction of soil matrix. Once adsorbed, these minerals provide a source of nutrients available for plant roots and can be replaced by other cations. The capacity of soil to store and exchange cations depends on the factors like soil texture, types of present minerals, organic matter content, soil pH and the composition of soil solution. In general, exchange capacity of most soils increases with the increase of soil pH. Simple organic acid, mostly produced by the microorganisms and plants, strongly influence the release of these elements from exchange complex. The aim of this study was to investigate the adsorption of copper and cadmium by vermiculite, kaolinite and synthetic goethite at different pH values, in presence and absence of oxalic and citric acid which are among the most abundant low molecular-weight organic acids in soil solution. To evaluate the adsorption of Cu and Cd under different conditions we conducted batch experiments in centrifuge tubes. In the absence of an acid, the amount of adsorbed metals on onto vermiculite, kaolinite and goethite increased with the increasing pH. Organic ligands, generally, decreased the amount of Cu and Cd adsorbed on these three sorbents. Oxalic acid had only minor effect on adsorption of cadmium on goethite. The observed tendencies were attributed to the processes of complexation between cations and organic ligands. The study confirmed the significant role that organic acids, as abundant plant and microorganisms' exudates, can play in enhancing the mobilization of adsorbed heavy metals in environment and in the similar geochemical processes.

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Evaluation of nanoclays in acid phosphatase immobilization to increase the phosphorus availability in soils

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The high phosphorous (P) retention in Chilean Andisols is one of the main problems in f crops productions. The catalysis of organic P by means of enzymes may be a suitable alternative to improve of this nutrient uptake. Studies have reported that the use of nanomaterials as immobilization support improves enzymatic stability and catalytic activity against other materials. Nevertheless, the production of nanoparticles with small diameters and a narrow size distribution is expensive and difficult. In soils derived from volcanic ash as Andisols, is possible to find different structures of nanoparticles like aluminosilicate with nano-ball (allophane) and nano-tube (imogolite) morphology within clay fraction. In this context, previous results from our research Group shown that acid phosphatase immobilized on allophanic clays increased its catalytic efficiency in 33%. The aims of this study were: i) to extract nanoclays from an Andisols of the Southern Chile and montmorillonite supplied by (AppliChem A6918, LOT 7W007719), and ii) to evaluate allophanic and montmorillonite clays and nanoclays as support to immobilize acid phosphatase. The nanoclays was extracted from Andisoil clays and montmorillonite clay, using the methodology described by Calabi-Floody et al. (2011). Allophanic clays and nanoclays were characterized, transmission electron (TEM) and scanning electron (SEM) microscopy, and atomic force microscopy (AFM). The enzymatic activities of free and immobilised phosphatase were assayed with 6 mM p-nitrophenylphosphate (p-NPP). The kinetics parameters (V_{max} and K_m values) were calculated according to Michaelis–Menten equation. Microscopy analysis showed that the methodology of the nanoclays extraction allowed obtain aggregates with different characteristic. Allophanic nanoclays were more homogeneous than montmorillonite nanoclays, and showed more porous density than montmorillonite. The studies of phosphatase immobilization showed that the V_{max} ranged from 9.2 ± 0.48 (free enzyme) to 13.6 ± 0.48 for allophanic nanoclays –phosphatase complexes (AN-P), The K_m values ranged from 0.11 (free enzyme) to 0.2 (AN-P) and the more efficient material resulted allophone clay-phosphatase increasing respect to free enzyme. In general, the catalytic activity of phosphatase supported in natural clays and nanoclays increased between 4 to 48% respect to the free enzyme. Hence these materials are suitable to phosphatase immobilization.

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Chitosan-intercalated montmorillonite as an adsorbent of the herbicide clopyralid in aqueous solution and soil/water suspensions

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Chitosan (CH), poly- β -(1,4)-2-amino-2-deoxy-D-glucose, is a naturally-occurring cationic polymer which has recently been used to prepare clay-based bionanocomposites. This work evaluates the ability of montmorillonite-CH bionanocomposites to adsorb the anionic pesticide Clopyralid (3,6-dichloropyridine-2-carboxylic acid) in aqueous solution and in soil/water suspensions, which could find application in the prevention and remediation of soil and water affected by the presence of this anionic pesticide. Low Molecular Weight CH (Sigma-Aldrich) was intercalated in SWy-2 Wyoming montmorillonite and the resulting montmorillonite-CH (SW-CH) complex was assayed as an adsorbent of Clopyralid from aqueous solutions at different pH levels, contact times, and initial pesticide concentrations. Desorption of the pesticide from SW-CH was also characterized using different extracting solutions. In addition, the ability of SW-CH to increase the adsorption of Clopyralid by two soils with different pH was investigated.

In contrast to the negligible adsorption of Clopyralid by the unmodified SWy-2 montmorillonite, the SW-CH bionanocomposite was a good adsorbent for the herbicide, although adsorption occurred only at pH levels where both the anionic form of the herbicide ($pK_a = 2.1$) and the cationic form of CH ($pK_a = 6.3$) predominated (i.e., pH 3-5). Adsorption of Clopyralid by SW-CH was rapid and mostly linear up to herbicide concentrations as high as 100 mg/l. High salt concentrations (0.1 M NaCl) promoted desorption of the adsorbed pesticide from SW-CH, thus indicating adsorption of Clopyralid occurred through an ion exchange mechanism on positively charged CH sites at the montmorillonite surface. Amendment of an acidic soil (pH 4.0) with SW-CH at rates of 5% and 10% led to a significant increase in Clopyralid adsorption, which was attributed to the prevalence of cationic exchange sites on SW-CH at the pH of the soil/water suspensions. In contrast, the increase in adsorption was negligible when SW-CH was added to an alkaline soil (pH 7.5), probably reflecting the absence of positively-charged sites in SW-CH at high pH values. These results indicate that montmorillonite-CH bionanocomposites could be effective adsorbents for the removal and/or immobilization of anionic pesticides in soil and water under slightly acidic conditions (pH 3-5).

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Adsorption of several contaminants by natural and modified clays as a sustainable application

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Some biodegradable materials are used for adsorption of chemical contaminants: lignins (Valderrabano et al., 2008) and also clays and clay minerals, whose colloidal properties, ease of generating structural changes, abundance in nature, and low cost make them very suitable for this kind of applications.

There are different materials used in the adsorption and immobilization of chemical contaminants, most of whom remain under patent, so they do not know the procedures and products used, but in all cases the safety and / or biodegradability of materials used is an important issue in their choice for environmental applications.

The most used are based on the use of organo-montmorillonites and hydrotalcite (del Hoyo et al., 2008; Undabeytia et al. 2008). The clay materials have led to numerous applications in the field of public health (del Hoyo, 2007; Volzone, 2007) having been demonstrated its effectiveness as adsorbents of all contaminants.

We have studied the adsorption of several contaminants by natural or modified clays, searching their interaction mechanisms and the possible recycling of these materials for environmental purposes and prevention of the public health.

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Adsorption of methylene blue by different low cost materials for practical classes of environmental chemistry

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Methylene blue (MB) has wide applications, which include coloring paper, temporary hair colorant, dyeing cottons, and wools. Although not strongly hazardous, it can cause some harmful effects, such as heartbeat increase, vomiting, shock, cyanosis, jaundice, quadriplegia, and tissue necrosis in humans. The effluents of the manufacturing and textile industries are discarded into rivers and lakes, changing their biological life (Stydini et al., 2004). The use of clean methods of low-priced and biodegradable adsorbents could be a good tool to minimize the environmental impact caused by manufacturing and textile effluents. Currently, adsorption processes have been studied because of their low cost and easy access, and also, dyes can be effectively removed by adsorption process in which dissolved dye compounds attach themselves to the surface of adsorbents.

The growing demand for efficient and low-cost treatment methods and the importance of adsorption has given rise to low-cost alternative adsorbents (LCAs). This work highlights and provides an overview of these LCAs for methylene blue (MB) comprising natural, industrial as well as synthetic materials/wastes and their application for this dye removal.

Advantages and disadvantages of adsorbents, favourable conditions for particular MB-adsorbent systems, and adsorption capacities of various low-cost adsorbents as available in the literature are presented (Gupta & Suhas, 2009). This subject has been used for practical classes of Environmental Chemistry, introducing students to the study of adsorption and its application for studying real cases. Conclusions have been reached from the obtained results with students and cooperative work was proposed for the practical class development in the laboratory.

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Cationic clays on human health: an overview

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Cationic clays are very extended compounds on the earth surface so they constitute the main component of soils and sedimentary rocks. Due to their presence and special properties that they have, mankind has used them with therapeutic aims from Prehistory, not being rare to find references to this subject in works of classic authors. During the Renaissance and with the appearance of the first Pharmacopeia, its use was regulated to a certain extent.

This work summarizes the beneficial and harmful effects of cationic clays upon human health. Their possible uses in pharmaceutical formulations are present in many subjects: from classical applications as orally and topical drugs to new trends as cancer therapy and geomedicine. Their influence, mainly in the case of cationic clays, on the development of such diseases as pneumoconiosis, silicosis and lung cancer, is described as well. The application of clays as excipients and their influence on the bioavailability of the organic active principle is also reviewed. Clay-modified electrodes have received attention in the development of electrochemical sensors and biosensors. This article also reviews this aspect for medical purposes. Finally, a summary of the fields in which clays could be applied to prevent public health is also provided.

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Protein-driven desorption curves of soil enzymes

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High-yield extraction of soil enzymes without bringing into solution humic substances is possible when a protein is added in the desorbing buffer. This added protein acts as a competing macromolecule for the sites of adsorption of the enzymes onto soil surfaces (heteromolecular exchange).

In order to understand interactions among soils and soil enzymes, we performed a series of extractions using different amounts of desorbing protein. Extraction was performed using a bead-beating procedure with different times: 10, 120 and 240 seconds. Three soils were used and five enzymatic activities were measured: arylsulfatase, beta-glucosidase, leucine-aminopeptidase, acetate-esterase, alkaline phosphomonoesterase. Increasing desorbing protein amount increased extraction yield, but the response was very different for each enzyme. Different minimal amounts of desorption protein were necessary to detect enzymatic activities in the extract, depending on the soil and enzymatic activity. A plateau was observed only for alkaline phosphatase in all three soils and for arylsulfatase in two soils even though the amount of protein used was up to about 30% of soil by weight. The other enzymatic activity showed a different dose-response effect, either linear or curvilinear and was soil-specific too. These results highlight that: i- a significant part of soil enzymes can be easily desorbed and; ii- interactions among soil and different soil enzymes can be understood with this simple approach.

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Synthetic allophane nanoparticles coated with iron oxide: Characterization and catalytic activity for phenol oxidation by Fenton-like reaction

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The use of clays and iron oxide minerals as catalysts in the Fenton-like reaction is a promising alternative due its low cost, abundance, and friendly environmental nature. Allophane is a clay-size mineral present principally in volcanic ash soils. This occurs as hollow spherules in the nanoscale range, with an external diameter between 3.5 and 5.5 nm and a wall thickness of 0.7–1.0 nm. Due to allophane properties, such as high surface area, high thermal stability, unique morphology and natural association with iron oxide. Recently, allophane coated with iron oxide was proposed as catalyst in the Fenton-like reaction for organic pollutant degradation. In this work, allophane nanoparticles with Si/Al ratio of 0.5 (AlSi1) and 1.8 (AlSi2) were synthesized and coated with 2 and 6% of iron oxide. TEM, FTIR and XRD characterized the samples. The structural properties were evaluated by N₂ adsorption-desorption isotherms at 77°K. The catalytic activities of the allophane samples coated with iron oxide in the Fenton-like reaction were evaluated by phenol oxidation in diluted aqueous medium (100 mL; 5x10⁻⁴ M). The experiments were performed at 25 °C and 40 °C, atmospheric pressure and pH 3.7. The phenol oxidation was carried out in presence of the oxygen (air flow 100 mL/min) and hydrogen peroxide (0.1M) at 2 mL/h during 4h of the reaction. The phenol oxidation was followed by gas chromatography and total organic carbon (TOC) decay. The sample characterization demonstrated that the allophane samples with Si/Al ratio of 0.5 and 1.8 were imogolite-like allophane and hydrous feldspathoids allophane, respectively. The study of the catalytic activities of allophane samples showed that the AlSi2 sample coated with iron oxide, achieved the higher catalytic activities. This result agrees with the highest surface area of these samples. About 63% of the initial amount of phenol was transformed into CO₂, at 40 °C using AlSi2 coated with 6% of iron oxide as catalyst. A very low dissolution of iron was observed after 4 h of the reaction (less than 2% of the initial iron content on the catalyst). An increment of iron dissolution was observed when the catalysts were reused; however, iron dissolution was less than 5 % of initial iron content on the catalyst. A similar phenol oxidation and TOC decay were observed when the allophane samples coated with iron oxide were reused, showing that the samples did not lose their catalytic activity, and can be used in successive treatment.

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Interactions of organic compounds with soil components – elucidating mechanisms on a molecular level

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Characterization of the structure and properties of humic substances in soils and natural waters is an intriguing problem in soil sciences. Humic substances consist of molecules covering a broad distribution of molecular size and composition involving different functional groups what is very challenging for molecular modeling. Taking this into account, we have chosen different model systems with functional groups typically present in humic substances, mainly the carboxylic group. Density functional theory (DFT) and density functional tight binding (DFTB) methods have been used for the simulations. Static calculations on the optimal structures and energetic of complexes and aggregates as well as extended molecular dynamics calculations based on the DFTB method have been performed.

Several types of models were developed:

- a) hydrogen bonded and cation bridged complexation of poly-acrylic acid (PAA) oligomers with acetic acid and the herbicide (4-chloro-2-methylphenoxy) acetic acid (MCPA)
- b) microhydrated complex of two PAA trimers arranged in parallel alignment as structural example for supramolecular contact of two HS chains by means of hydrogen bonds
- c) aliphatic chains anchored on polyene chains and terminated with carboxyl groups embedded in a local network of water molecules representing wet nano-regions
- d) spatially distributed four aliphatic oligomer chains terminated with carboxyl group interacting with varied number of water molecules
- e) microhydrated cation bridges (Al³⁺, Ca²⁺ and Na⁺) formed in a complex of two aliphatic chains terminated with carboxyl/carboxylate groups

Furthermore, interaction of alkali cations (Li⁺-Rb⁺) with black carbon (BC) were studied by using pyrene as BC model.

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The background of non-crystalline materials and its role in soil organic matter turnover in subtropical volcanic soils

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The high levels of soil organic matter (SOM), frequently found in soils with large content of non-crystalline minerals, are traditionally considered the result of strong organo-mineral interactions. Amorphous oxides are likely to provide active sites for SOM sequestration at the colloidal level. Considering that preservation of SOM is favoured by adsorption of humic colloids onto mineral surfaces, as well as by physical inaccessibility of particulate SOM fractions after encapsulation in the mineral matrix, some authors have recently correlated the complex fractal structure in allophane particles with the low availability of SOM to microbes and enzymes. Apart from the above extrinsic SOM stabilization factors, some studies have also considered the intrinsic recalcitrance of SOM derived from its condensed three-dimensional structures with large amounts of disorderly arranged aromatic “building blocks”.

In order to obtain information about the role of non-crystalline minerals in the concentration and the quality of the SOM, the mineralogical composition was studied and humic substances were analyzed by ¹³C NMR and analytical pyrolysis in 30 sites from Tenerife Island (Spain). The sampling plots embraced a variety of progressive concentrations of amorphous materials, including seminatural and agricultural (vineyard) soils. The content of these materials (g . kg soil⁻¹) was measured from $\text{AlO} + \frac{1}{2} \text{FeO}$ index, as well as in terms of P retention. In order to distinguish inorganic forms of amorphous Al, the Alp/Alo ratio was calculated, and the allophane content was estimated from $(\text{Alo} - \text{Alp})/\text{SiO}$ ratio.

The humic substances were isolated by alkaline extraction fielding different fractions: humic acids, fulvic acids and humin. Up to 90 main analytical descriptors of the SOM were analyzed by statistical treatments mainly non-linear multidimensional scaling and factorial discriminant analysis. Our results reveal mutual relationships between the variables to greater extent explaining the accumulation of SOM, and showed conspicuous correlations between soil mineral composition and molecular characteristics of the main SOM fractions.

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Organo-mineral features related to field infiltration parameters in calcimorphic Mediterranean agricultural soils

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In semiarid soils subjected to rain events with high erosion risk is especially relevant the amount of soil organic matter (SOM) and the formation of macroaggregates from fine particles. In this scenario, soil infiltration rate depends on soil intrinsic factors such as: granulometric size, clay type, content of oxides, hydroxides and calcium carbonate, aggregate size and stability, and total amount and quality of SOM.

In this study, SOM characteristics associated to aggregate stability and water infiltration curves were studied. The plots studied corresponded to seminatural and agricultural calcimorphic soils under Mediterranean climate in the central Spain.

In field experiments, the soil infiltration curves, water holding capacity and parameters b and c of the empirical Kostiakov's equation were estimated using a double-ring infiltrometer. In laboratory conditions, soil physical properties, such as aggregate stability or particle-size distribution were determined and the humic acid was isolated and characterized by visible spectroscopy and analytical pyrolysis combined with gas chromatography and mass spectrometry.

Joint processing of the data matrix including soil physical properties in addition to SOM characteristics by simple and multiple regressions models, principal component analysis and discriminant analysis suggested: i) the most diagnostic variables as regards soil infiltration patterns (e.g., cumulative water infiltration, bulk density, structural stability, infiltration rate, parameter c and parameter b, of the Kostiakov's curve, ii) the fact that infiltration parameters behave as emergent properties in close connection with SOM features reflected by its molecular composition. In this case, valid even for taxonomical differentiation of the original soil types: Calcixercepts, Xerorthents and Xeralfs Petrocalcic, iii) the fact that moderate hydrophobicity conferred to the humic acid by its alkyl domain in addition to a low condensed, flexible aromatic skeletal structures could be associated to the improvement of soil physical properties.

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Adsorption of the insecticidal protein of *Bacillus thuringiensis* subsp. *kurstaki* by soils: effects of iron and aluminium oxides

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Since transgenic *Bacillus thuringiensis* (Bt) plants may impact soil ecosystem by the persistence of the insecticidal protein, so-called Bt toxin, concerns about their environmental security arose as the worldwide growth of Bt plants. The adsorption of Bt toxin by latosol (LS), latosolic red soil (LRS), red soil (RS), yellow soil (YS) and paddy soil (PS), as well as by these soils removed different forms of Fe and Al oxides (organic fraction, free, amorphous, interlayer, adsorption and exchangeable), were studied. The objectives were to elucidate effects of iron (Fe) and aluminum (Al) oxides on Bt toxin adsorption, and to provide references for the ecological risk assessment of transgenic Bt plants. The main results are:

- 1) The adsorption amount of Bt toxin by soils removed organic bound Fe (Fep) and Al (Alp) increased in comparison to their native soils, and the increment for LS, LRS, RS, YS and PS were 18.5%, 3.5%, 12.4%, 15.5%, and 52.9%, respectively. The increase in adsorption amount of Bt toxin was in positive correlation with the content of removed Fep, and in negative correlation with the content of removed Alp.
- 2) After removal of free Fe (Fed) and Al (Ald) oxides, the adsorption amount of Bt toxin by these soils significantly decreased. This may be due to the removal of Fed and Ald induced the increase of surface negative charge and the decrease of specific area of soils.
- 3) After removal of amorphous Fe (Feo) and Al (Alo) oxides, the adsorption of Bt toxin by these soils decreased by 6.3%-34.6%, in comparison to native soils, which might be due to the decrease of PZC and the increase of permanent negative charge.
- 4) After removal of interlayer Fe-Al (InFe-Al) and exchangeable Fe-Al oxides (ExFe-Al), the adsorption amount of Bt toxin by tested soils decreased significantly, and the former was more observably. In comparison to native soils, after removal of adsorbed Fe-Al oxides (HyFe-HyAl), the adsorption by LS, LRS and RS reduced 31.7%, 25.4%, and 26.1% of the decrement, respectively; meanwhile, the decrement for YS and PS was only 3.1% and 6.3%.
- 5) The effect degree of Fe and Al oxides on the adsorption of Bt toxin was different for 5 tested soils, although the effect of Fed and Ald was the greatest. For LS, LS and RS, the effect degree of other oxides was in order of InFe(Al) > Feo(Al), HyFe(Al), Fep(Al) > ExFe(Al); for YS, it was ExFe(Al) > Fep(Al) > Feo(Al), InFe(Al), HyFe(Al); for PS, it was Feo(Al), InFe(Al), Fep(Al) > ExFe(Al), HyFe(A...

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Description of the adsorption of Cu and Zn on allophanic clay using the Capacitance Constant Model

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Surface Mechanistic Models are useful tools to predict the availability of the metals on soil solution and describe the adsorption mechanisms that can occur on the surface. The capacitance constant model (CCM) and Double Layer Model have been used to predict the adsorptive affinities of divalent metal ions on different surfaces. In adsorption studies of Cu and Zn on montmorillonite or ferrihydrite have been proposed that these metals form monodentate (>SOM+) and bidentate (>SO₂M) complexes. The aim of this work was evaluate the Cu and Zn adsorption on allophanic clay extracted from an Andisol by CCM. Two adsorption experiments were conducted. The first one was a monocomponent system (Cu or Zn adsorbed) and, the second one was a multicomponent system (Zn(+1mMCu) or Cu(+1mMZn). The initial Cu or Zn concentrations varied from 0.05 to 5 mM. All experiments were carried out in batch system for 24 h of shaking at pH (5.0), ionic strength (KCl 0.1 M) and temperature (25 °C) constants, with clay fraction/solution ratio 0.1 g/10 mL. The metals in solution were determined by atomic absorption spectrophotometer. The amount of adsorbed metals was calculated as the difference between the amount initially added and the remaining in solution after 24 h. Data were fitted by the CCM assuming the formation of monodentate and bidentate inner sphere complexes for Cu²⁺ and Zn²⁺ using FITEQL 3.5 program. The intrinsic surface complexation constants (K_{int}) were determined using the adsorptive data at pH, ionic strength and temperature constants. Result from adsorption isotherms on allophanic clay showed that the affinity of Cu was around 20 % higher than Zn when the initial concentration was 5 mM. When Cu was adsorbed in presence of Zn, it was not observed an effect of Zn on Cu adsorption at highest concentrations. However, Zn adsorption was decreased in presence of Cu approximately in 51 %. The fit values using CCM for Zn and Cu (M) were log K_{int}(OS)_{2M} -3.72 and -2.78 for bidentate complex and log K_{int}SOM+ -2.75 and -1.22 for monodentate complexes, respectively. At low concentration, Cu was mainly adsorbed as monodentate complexes; however, Zn was adsorbed as bidentate complexes at all evaluated concentrations. Copper in presence of Zn was not fitted well at low concentration, nevertheless, at higher concentration formed monodentate complexes. Conversely, the model was able to fit Zn (in presence of Cu) and evidenced the presence of monodentate complexes.

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Adsorption and catalytic activity of ectomycorrhizal fungal phosphatases in contact with two tropical soils

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Phosphatases secreted in soil by microorganisms, such as ectomycorrhizal fungi, play a role in hydrolysis of organic phosphorus (Po) and release of orthophosphate (Pi) which is the form available to plants. The role of phosphatases may be important for highly weathered tropical soils owing to deficiencies in Pi. However, once in soil, phosphatases may be adsorbed on soil organo-mineral surfaces. Adsorption limits mobility and hence the zone of action, of the enzyme, may afford physical protection against microbial breakdown and may modify the expression of catalytic activity because of conformational changes or preferential orientation of the active site at the solid-solution interface. The aim of this study was to determine the role of organic and mineral components of tropical soils on the adsorption and modification of activity of fungal phosphatases. Phosphatases were obtained by culture of three ectomycorrhizal fungi strains in liquid medium. The catalytic activity of secreted phosphatases was measured as function of pH using paranitrophenyl phosphate as substrate, in solution, in soil suspension and in the supernatant solution of soil suspensions. A vertisol and a ferralsol were studied and for each soil the clay-sized and silt-sized fractions compared and the effect of chemical removal of organic and mineral coatings studied. Marked differences between phosphatases were observed in the nature of the interaction between enzyme and soil as a function of pH. However differences between soils and soil physical and chemical fractions were less marked. The interaction of phosphatases with soil colloids was determined more by the origin of phosphatases than the nature of soil colloids with which they interacted. These results have strong implications for the understanding of fungal phosphatases in phosphorus cycle, and to guide future research.

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Changes in soil quality indicators under humic substances application in liquid form

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The use of liquid of humus is a novelty form for incorporating organic carbon (OC) in agricultural soils since it is possible to apply it through the irrigation systems. This liquid extract consists of a mixture of humic substances (HS), humic (HA) and fulvic acids (FA), which can exert different beneficial effects on soil properties. The aim of this work was to evaluate the effect the application of these HS on some chemical, microbiological and biochemical properties of an alkaline orchard soil. Commercially available liquid of humus was fractionated into HA and FA. Different treatments were set considering the source of OC (AH, AF, or AH+AF). A hundred grams of dry soil (<2mm, pH_{H2O}=7.5) receiving the application of HA, FA or AH+FA at the same C rate (4.57mg C 100g⁻¹ soil) were incubated in opened plastic bags (25°C, 30 days, close to field capacity). A control soil without HS was also included. Given that LH contains potassium (K), treatments with the application of K (equivalent to that found in the HS treatments) were included as well. After the incubation, the soil was analyzed for chemical (pH, water soluble C [CWS]), microbiological (population of bacteria, fungi and actinomycete [ufc g⁻¹]) and biochemical (β-glucosidase [UBG=μg para-nitrophenol g⁻¹ h⁻¹], dehydrogenase [UDH=μg TFP g⁻¹ 24h⁻¹] and fluorecein diacetate [UFDA=μg fluorecein g⁻¹ h⁻¹] activities) parameters. The experiment was performed in triplicate. Soil pH in all treatments (7.3-7.9) was similar to that found in the natural soil. The Cws was 7, 11, and 10 times higher (p<0.001) in the soils treated with AH, FA, and AH+FA, respectively, in comparison to that observed in the control (33 mg C kg⁻¹). The microbial populations showed some treatment effect but without a definable trend. By contrast, the enzymatic activity, UDH and UFDA, was significantly (p<0.001) affected by the application of HS and the treatments followed the sequence: AH>AH+FA>FA>=others. In the HA treatment those activities showed values of 421 UDH and 121 UFDA, respectively. β-glucosidase activity tended to be higher in the same treatment (63.9 UBG). The presence of K caused a depression of the UDH attributable to osmotic stress, specially in the treatment without application of HS. Enzymes determined in this study are directly associated with microbial respiratory activity, confirming that determination of metabolites may be a more sensitive property stocks that counts. Acknowledgments: Project DGIP-USM N° 281028.

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Changes in zinc adsorption in an alkaline soil in the presence natural humic substances

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Liquid of humus (LH) is a liquid extract containing a mixture of humic substances (HS), humic (HA) and fulvic acids (FA). The application of these kind of organic amendments is being used in soils of the arid and semi-arid northern zone of Chile to improve some soil properties like the poor levels of organic carbon (OC) and the structure in the rizosphere of drip-irrigated plants. Many of these soils also present a low availability of Zn because of the alkalinity and/or the low natural levels of this element in the parent material. Humic and fulvic acids can modify the interaction of soil particles with micronutrients like Zn, thus changing their retention and availability. The objective of this work was to study the retention of Zn in an alkaline soil (pH=7.5) when this element was applied together with different mixtures of HS or applied in a HS pre-treated soil. The retention characteristics of Zn were studied carrying out sorption isotherms at constant ionic strength (0.05 M KNO₃) and at soil pH. Samples of 1.00±0.01 g of dry soil were placed in 50-mL centrifuge tubes, and 10 mL of equilibrating solution of Zn (5-70 mg L⁻¹) were added to each tube. Two sets of sorption isotherms were carried out: 1) soil receiving the application Zn, or the application of Zn+HS obtained from LH (Zn+HA, Zn+FA, Zn+AH+AF [C-AH:C-FA=1:1]) at the same C rate (4.57 mg C kg⁻¹); 2) the soil was pre-treated with AH, FA, HA+FA, incubated for 30 days at 25°C and field capacity, and then isotherms were carried out using the same procedure and initial Zn concentrations. In this case, a control soil incubated but without HS pre-treatment was also included. Experimental data were fitted to Langmuir's models. The experiments were performed in duplicate. Results indicated that HS decreased the Zn sorption affinity to soil particles. Humic acid was more effective in decreasing the Zn sorption in comparison to AF or the mixture AH+AF, specially when was applied together with the metal. The HA pre-treated soil showed a water soluble C concentration 1.3-1.6 times lower in comparison to the FA and AH+FA pre-treated soils, but still it showed a lower Zn affinity. The higher molar volume and carboxyl content of HA could explain these findings. Soils pre-treated with AF and AH+AF tended to show only a slight increase of Zn sorption with respect to control in comparison to soils that received the Zn+AF and Zn+HA+FA. Acknowledgments: Project DGIP-USM N° 281028.

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Enhancement of phosphorus availability in acidic soil by using humic acid and crude fulvic acids

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Low P availability is common in acid soils. This problem is caused by high amounts of Fe and Al in acid soils. Though many researches have been done to solve this problem, simple and cheap way of mitigating P fixation is essential. Thus, this study was conducted to determine the effect of humic acid (HA) and crude fulvic acids (CFA) on the availability of P in an acidic soil. Nyalau Series (Typic Paleudults) was used as soil medium in this experiment. HA and CFA were extracted from a well decomposed tropical peat soil collected from Mukah, Sarawak Malaysia. The isolation of HA and CFA was done using standard procedures. Purified and dried HA was applied to Nyalau Series at 0.3, 0.6 and 0.9g. However, 3, 6 and 9 mL were used for CFA. These organic fractions and their mixtures were tested by combining them with TSP fertilizer. Firstly, the soil was thoroughly mixed with treatments. Afterwards, treated soil was moistened up to 75% field capacity. The samples were incubated for 15 days and data were collected for every 3 days. Available P, exchangeable cations, pH (water and 1M KCl) and available Fe were determined using standard procedures. The soil pH values either in water or 1M KCl were acidic for all treatments. Available P increased with application of HA and CFA. Available P in humic fractions treatment increased with incubation period. The negative charges or potential positive charges of HA and CFA could be the main reason for the increase in P availability. They could also be the main cause of the increase in K, Ca, Mg, and Na. TSP alone showed lower P availability as compared to humic fraction treatments suggesting that TSP can only release P in a short period. Results of exchangeable Fe for humic fractions treated soil proved that available P related to Fe content. The high amount of Fe recorded for humic fractions treatments may be because of the associated P which might have been released from Fe-P fixation. In conclusion, use of TSP could be good on short term basis due to its high solubility. Thus it is not recommended to apply TSP for a long period. TSP alone was not as effective as when it was mixed with humic fractions. This suggests that addition of humic substances together with TSP enhances availability of P by retaining it for a long period. However, the retention process was not well covered in this study and it is recommended that further experiment is conducted to substantiate these findings.

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Thermodynamic database updating to include synthetic chelating agents for soil behavior prediction

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Poliaminocarboxylate and polyaminophenolcarboxylate chelating agents analogous to EDTA and EDDHA have been profusely studied by our research team during the last 25 years because this family of iron fertilizers are widely used in soils formed under Mediterranean conditions. In the last years new chelating agents have been also designed and synthesized and several of them have been proposed to be included in the current European Directive on Fertilizers.

For new chelating agents validation, once analytical determinations have been done, computational modelization using well-known speciation equilibrium programs (MINTEQA2 and recently VMinteq) has been successfully used and tested on several new EDDHA-analogous chelating agents to predict their behavior in soil-plant system.

For solution and soil solution modelization studies, first the thermodynamic database used by the speciation equilibrium program has to be modified to include all requested parameter for every new compound. For this, protonation and formation stability constants for the more significant metal complexes were previously determined for those proposed chelating agents using both photometric and potentiometric techniques or from the bibliographic references. Then case Lindsay's thermodynamic database was modified in order to include the news chelating agent parameters. Requested parameters for the following chelating agents were recorded in Lindsay's database and, therefore, this database was modified and updated including all chelating agents analogous to EDDHA or EDTA (o,o-EDDHA, o,p-EDDHA, rac-o,o-EDDHA, meso-o,o-EDDHA, o,o-EDDHSA, o,o-EDDH5MA, o,o-EDDHA4MA, EDDS, IDHA, DCHA and HBED,...).

Once database has been updated including those chelating agents above mentioned, equilibrium reactions with solid phase could be performed as soon as corresponding adsorption, interaction and solubilization parameters with soil fractions (clays, organic matter, oxyhydroxydes and inorganic fractions) are determined. Even solution and soil solution modelization has been already determined for these organic compounds, interaction with soil solid phase is crucial in order to know the reactivity of these polyaminophenolcarboxylates in soils for environmental impact.

All requested database parameters from those chelating agents have been already published but the resultant database including all parameters would be very convenient to be available for subsequent modelization studies.

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