**Isabella Olga Zelano**

Institut des Dynamiques de la Surface Terrestre

Université de Lausanne

Contents

# 1. Curriculum vitae

Isabella Olga Zelano

## Esperienze professionali

**12.2019-présent**: Post-Doctoral position, senior SNF researcher: *"Electron flows across organo-microbe-mineral units and impact on soil carbon cycling"*.
Institut des Dynamiques de la Surface Terrestre (IDySТ), Université de Lausanne (Unil), Suisse.
Advisor: Prof. J. Peña

**01.2019-11-2019**: First Assistant, Post-Doctoral position: "*Cryptic and non-cryptic cycling of redox-active metals like Mn and Fe".*
Institut des Dynamiques de la Surface Terrestre (IDySТ), Université de Lausanne (Unil), Suisse.
Advisor: Prof. J. Peña

**04.2015-02.2018**: Post-Doctoral position: *"Role of hyperaccumulating plants in the biogeochemical cycle of nickel: distribution, chemical speciation and isotopic fingerprint".*
Centre de Recherche Pétrographiques et Géochimiques CNRS,
Laboratoire Interdisciplinaire des Environnements Continentaux, Université de Lorraine, France
Advisor: Dr. E. Montarges-Pelletier, Dr. C. Cloquet

**01.2010-12.2010**: Graduate assistant: *"Biochemenergy: reduction of the ash content in biomasses (compost) and increasing of the amount of polar groups by performing sulfonic reactions".*
Organic chemistry department, Università degli Studi di Torino
Advisor: Prof. E. Montoneri

## Istruzione, formazione e titoli

**2011 – 2014** : Dottorato in cotutela, "*Chemistry and Material Science"* Università degli Studi di Torino (UNITO) e "*Earth and Environmental Science"* de l'Institut de Physique du Globe de Paris (IPGP) – Dirrettori: Prof. O. Abollino (UNITO) et Prof. MF. Benedetti (IPGP). *Titolo: "Availability and mobility of heavy metals in two antagonist ecosystems: Antarctica vs Brasil*"

**2009** Esame di Stato per l'abilitazione alla professione di chimico-Torino

**2009** Laurea Specialistica in *Metodologie chimiche avanzate* (curriculum Chimica Analitica) Università degli Studi di Torino (Erasmus Programme at Aberdeen University, Scotland, 7 months) – Direttore: Pr. E. Pramauro (UNITO) and Pr. J. Feldmann (Univ. Aberdeen). *Title: "Differences between uptake and accumulation of Mercury and Methylmercury in plants".*

**2006** Laurea Triennale in *Chimica*, Università degli Studi di Torino - Stage nel laboratorio di analisi dell'ospedale San Giovanni Battista, Molinette, Torino – Direttore: Prof. G. Daniele *Title: "Development of an analytical method for the determination of anti-epileptic drugs in plasma with High Performance Liquid Chromatography (HPLC)".*

**2002** Nomina di Cultore della materia "Chimica Anilitica" presso la Facoltà di Farmacia , Università degli Studi di Torino.

**2002** Diploma di Maturità Classica

## Corsi di formazione

**2015** X-Ray Absorption Spectroscopy School, Montpellier University, France

**2011** Speciation and bioavailability School, Wageningen University, Netherlands.

## Capacità e competenze tecniche

- Isotope Chemistry, Inductively Coupled Plasma Mass Spectrometry, Multicollector MC-ICP-MS;
- Major and trace element analysis, Atomic Emission Spectroscopy (ICP-AES), Atomic Absorption Spectroscopy (AAS), ICP-MS quadrupole, High Resolution-ICP-MS;
- Elemental Analyser CHN;
- Dissolved Organic Carbon;
- Electrochemistry, potentiometric titration ;
- Ion chromatography;
- Gas-chromatography basics;
- Chemometric data processing ;
- Speciation software Visual MINTEQ ;
- Planification sampling campaigns :
    - Surface water, soil, ore, mining waste in the mining sites of Barro Alto and Niquelandia, State of Goias, Brazil (Doctorat)
    - Soil and hyperaccumulating plants in Sabah rain forest, Borneo, Malaysia (Postdoctorat)
    - Water and sediment cores in the polluted area of the Ohrida lake, Albania (Postdoctorat)
    - Surface water and soil samples in Ni polluted areas of Upper Valais, Switzerland (Postdoctorat)

## Borse di studio e premi

- Erasmus Grant, University of Aberdeen, Scotland, 2008.
- Premio per il miglior Poster, Congrès des doctorants de l'Institut de Physique du Globe de Paris, 2012

## Attivita di Peer review

Environmental Science & Technology

## Collaborazioni internazionali

- Prof. Adrien Mestrot, Institute of Geography, Soil Science, University of Bern, Switzerland.
- Dr. Moritz Bigalke, Institute of Geography, Soil Science, University of Bern, Switzerland.
- Dr. Emmanuelle Montarges-Pelletier, Laboratoire Interdisciplinaire des Environnements Continentaux, Université de Lorraine, France.
- Dr. Christophe Cloquet, Centre de Recherche Pétrographiques et Géochimiques, Université de Lorraine, France.
- Dr. Antony Van der Ent, Centre for Mined Land Rehabilitation, Sustainable Minerals Institut, University of Queensland, Australia.

- Prof. Yann Sivry, Biogéochimie à l'Anthropocène des Élements et Contaminants Émergents, Institut de Physique du Globe de Paris, France.
- Prof. Khalil Hanna Ecole Nationale Supérieure de Chimie de Rennes, France.
- Prof. Vittorio Boffa, Department of Chemistry and Bioscience, Aalborg University, Denmark

## 2. Progetti di ricerca finanziati e attività istituzionali

### Progetti finanziati

**Matterhorn Grant (Principal Investigator) -** 12.2021-05.2022 - Commission de la Recherche et le Décanat, Université de Lausanne. Project title: *"Metal dynamics at the surface of bio- and non-biodegradable plastic film"* - 9438 CHF.

**Grant from IDyST Department (PI) -** 09.2021-12.2022 - Université de Lausanne. Contribution to support developing my own research project about the study of microplastic degradation in the environment, in parallel to my present post-doctoral research appointment with Prof. Pena - 5662 CHF.

**Tremplin Grant (PI) -** 02.2021-12.2021 - Equal Opportunity Office, Université de Lausanne, to help the next generation of female academics. The received grant partially relieved me of some technical tasks in laboratory work relative to my present post-doctoral research appointment with Prof. Pena and allows me to develop my own research project on microplastic degradation in the environment - 23000 CHF.

**Agassiz Foundation (PI) -** 09.2020-12.20210 - Université de Lausanne. Grant to support research in Natural Sciences. Project title: *"Plastic debris as new soil reactive phases influencing metal biogeochemical cycles"* - 7000 CHF.

**Successful application to the French National Synchrotron Facility SOLEIL (PI)** – 2016 - Project title: *"Identifying the link between Ni speciation and the corresponding isotopic fractionation in different mineral and biological matrices".*

**Bando Vinci –** 2012 - Università Italo Francese, Co-tutoring PhD project funding. Project title: *"Nickel dynamics in soils: Speciation and Mobility"* - 4500 €.

### Attività istituzionali

Membro della commissione di dottorato : Esaminatrice della tesi di dottorato di Mme Evelyne Adjei Mensah, 03.02.2022 presso l'Institut de Physique du Globe de Paris, Ecole Doctorale STEP'UP n°560 Science de la Terre et de l'Environnement ö
*"Dissémination environnementale du Chrome en contexte minier : études physique, chimique et isotopique".*

Membro eletto (Corpo intermediario) del Conseil de l'Institut des Dynamiques de la Surface Terrestre (IDyST), Université de Lausanne (09.2020 – presente).

Membro eletto (Corpo intermediario) del Consiglio di Dipartimento di Chimica Analitica, Università degli Studi di Torino (01.2011-12.2011).

## 3. Diffusione dei lavori scientifici

### Invited talks

1. **I.O.Zelano**, "*Ni isotopic fractionation and Ni recycling in the upper soil layers*", Laboratoire d'Hydrologie et de Géochimie de Strasbourg, January 2018 .
2. **I.O.Zelano**, *"The study of Ni biogeochemical cycle through an isotopic approach",* Institut des dynamiques de la surface terrestre (IDyST), Université de Lausanne, January 2018 .

### Contribution to conferences

***Talks***

1. I. O. Zelano, J. Golzález Holguera, Jorge Spangenberg, **J. Peña**, *Effect of manganese oxides on organic carbon assimilation and $CO_2$ release by Pseudomonas putida KT2440*, American Chemical Society Spring, 2022, San Diego, Carlifornia, USA.
2. **I. O. Zelano**, J. Golzález Holguera, Jorge Spangenberg, J. Peña, *Dynamics of carbon cycling by soil bacteria in presence of manganse oxides*, Goldschmidt Virtual Conference, 2021, Lyon, France.
3. **I. O. Zelano**, J. Golzález Holguera, Jorge Spangenberg, J. Peña, *Oxidation of glucose by Mn oxide and change in carbon bioavailability for soil bacteria*, Swiss Geoscience Virtual Meeting, 2020.
4. **I. O. Zelano**, J. Golzález Holguera, J. Peña, *Oxidation of bioavailable carbon substrates by Mn oxides*, Goldschmidt Conference, Barcelone, Spain, August 2019.
5. **I. O. Zelano**, C. Cloquet, G. Echevarria, A. Van der Ent, F. Fraysse, E. Montarges-Pelletier, *Ni Isotopic Fractionation and Ni recycling in the upper soil layers*, International Workshop on Ni Geochemical cycle: from mining exploration to ecotoxicity, Nancy, France, October 2017.
6. **I. O. Zelano**, C. Cloquet, G. Echevarria, A. Van der Ent, F. Fraysse, E. Montarges-Pelletier, *Ni isotopic fractionation and the role of hyperaccumulating plant*, Goldschmidt Conference, Paris, France, August 2017.
7. S. Dong, C. Cloquet, E. Montarges-Pelletier, **I. O. Zelano,** *Investigation of using Ni isotopes as anthropogenic source tracer in river sediments: a preliminary study*, Goldschmidt Conference, Yokohama, Japan. August 2016.
8. **I. O. Zelano**, Y.Sivry, C. Quantin, A. Gelabert, M. Tharaud, A. Maury, S. Nowak, K. Phalyvong, O. Abollino, M.F. Benedetti, *How can we quantify the contribution of each Ni bearing phase to the total Ni exchangeable pool?* Goldschmidt Conference, Prague, CZ, August 2015.
9. **I. O. Zelano**, Y.Sivry, C.Quantin, A. Gelabert, M. Tharaud, A. Maury, S. Nowak, K.Phalyvong, O. Abollino, M.F. Benedetti, *An Isotopic Exchange Kinetic Model to describe the role of Ni bearing phases on its mobility*. RST Conference, Pau, France, October 2014.
10. **I. O. Zelano**, Y. Sivry, C. Quantin, A. Gelabert, M. Tharaud, D. Jouvin, E. Montarges-Pelletier, G. Garnier, R. Pichon, S. Nowak, S. Miska, O. Abollino, M. F. Benedetti, *Ni availability/Ni Solid Phases in Soild and Waters from Ultramafic Complexes in Brazil: A Narrow Relationship*. Goldschmidt Conference, Florence, Italy, August 2013.
11. **I. O. Zelano**, Y. Sivry, M. F. Benedetti, *Nickel (bio)availability in ultramafic soils from Goïas, Brazil: an overlook of the soil compartments*, Congrés des Doctorants, Ecole Doctorale des Sciences de la Terre de l'IPGP, de l'Université Paris Diderot et de l'ENS, Mars 2013.

12. C. Quantin, D. Jouvin, A. Gélabert , E. Montarges-Pelletier, Y.Sivry, **I. O. Zelano**, R. Pichon, J. Garnier and M.F. Benedetti, *Combining µSXRF, EXAFS and Isotopic Signature to understand the Ni cycle in Impacted Ultramafic Soils*, Goldschmidt Conference, Montréal, Canada, June 2012.
13. **I. O. Zelano**, Y. Sivry, D. Jouvin, M. Tharaud, C. Quantin , A. Gélabert, E. Montarges-Pelletier, R. Pichon, J. Garnier , O. Abollino and M. F. Benedetti, *Nickel (bio)availability in ultramafic systems from Goïas, Brazil*, Summer School of Contaminated Soil, Champs-sur-Marne, France, June 2012.
14. **I. O. Zelano**, Y. Sivry, D. Jouvin, M. Tharaud, C. Quantin , A. Gélabert, E. Montarges-Pelletier, R. Pichon, J. Garnier , O. Abollino and M. F. Benedetti, *Nickel (Bio)availability in Ultramafic Systems from Goias, Brazil: an overlook of the soil compartments*, Interface Against Pollution Conference (IAP), Nancy, France, June 2012.
15. **I.O. Zelano**, M. Malandrino, A. Giacomino, O. Abollino, *Modalità di interazione e trattenimento di ioni metallici su substrati solidi di origine naturale,* Incontri di Scienza delle Separazioni, Torino, May 2011.

***Poster***

***1.*** **I .O. Zelano**, J. Golzález Holguera, J. Peña, Oxidation of bioavailable carbon substrates by Mn oxides and the competition effect with bacteria, Fribourg Swiss Geoscience Meeting, November 2019.

***2.*** **I. O. Zelano**, J. Golzález Holguera, J. Peña, *Oxidation of bioavailable carbon substrates by Mn oxides*, flash oral communication at Goldschmidt Conference, Barcelone, Spain, August 2019.

***3.*** **I. O. Zelano,** E. Montarges-Pelletier, R. Gley, F. Fraysse, G.Landrot,C. Cloquet., *Ni isotopic fractionation at the interface with mineral phases*. Goldschmidt Conference, Bostin, USA, August 2018.

***4.*** **I. O. Zelano,** C. Cloquet, G. Echevarria, N. Janot, A. van der Ent, Fraysse F., Montarges-Pelletier E., *Nickel Isotopic Fractionation when reacting with Organic Acids and the role of Hyperaccumulating plant*, poster at International Conferences On Serpentine Ecology, Pogradec, Albania. June 2017:

***5.*** **I. O. Zelano**, C. Cloquet, E. Montarges-Pelletier, F. Fraysse, S. Dong, *Ni isotopic fractionation due to interaction with small organic acids and purified humic acids*. Goldschmidt Conference, Yokohama, Japan, June 2016.

***6.*** O. Abollino, M. Malandrino, **I. O. Zelano**, A. Giacomino, S. Buoso, Y. Sivry, M.F. Benedetti, *Characterization Of The Element Content In Lacustrine Ecosystems In Terra Nova Bay, Antarctica*, XXIV Congresso della Divisione di Chimica Analitica della SCI, Sestri Levante (GE), September 2013.

***7.*** **I. O. Zelano**, M. Malandrino, A.Giacomino, S. Buoso, Y. Sivry, M. F. Benedetti and O. Abollino, *Natural Processes occurring in small lakes from Terra Nova Bay Antarctica,* , Giornate Italo-Francesi di Chimica, Marseille, April 2012.

***8.*** **I. O. Zelano**, Y. Sivry, D. Jouvin, M. Tharaud, C. Quantin, A. Gélabert, E. Montarges-Pelletier, R. Pichon, J. Garnier , O. Abollino, M. Malandrino and M. F. Benedetti, *Nickel (bio)availability in ultramafic systems from Goïas, Brazil: an overlook of the compartment.* Giornate Italo-Francesi di Chimica, Marseille, April 2012.

***9.*** **I. O. Zelano**, Y. Sivry, M. F. Benedetti, *Nickel (bio)availability in ultramafic soils from Goïas, Brazil: an overlook of the soil compartments,* Congrés des Doctorants, Ecole Doctorale des Sciences de la Terre de l'IPGP, de l'Université Paris Diderot et de l'ENS, April 2012.

## 4. Public engagement

### Organizzazione di manifestazioni scientifiche

Co-animatrice de la tavola rotonda « *4 per Mille soil carbon* », Institut des Dynamiques de la Surface Terrestre, Université de Lausanne (22.07.2020).

### Volgarizzazione scientifica

- Giornate porte aperte per scuola media e superiore, Université de Lausanne, 2019.
- Giornate porte aperte per scuola media e superiore, Université de Lorraine, Nancy, 2016.
- Animatrice per la Notte dei Ricercatori, Università degli Studi di Torino, 2011-2014.
- Animatrice per Fête de la Science, Institut de Physique du Globe de Paris, 2012-2014.

## 5. Produzione Scientifica

### Pubblicazioni

**Reported IF are relative to the year of publication*

***1.*** **I.O. Zelano**, C. Cloquet, A. van der Ent, G. Echevarria, G. Gley, G. Landrot, S. Pollastri, F. Fraysse, E. Montargès-Pelletier *Coupling nickel chemical speciation and isotope ratios to decipher nickel dynamics in the Rinorea cf. bengalensis-soil system in Malaysian Borneo*, Plant and Soil (2020), 454 (1-2) 225-243. (IF=4.192)

***2.*** **I.O. Zelano**, C. Cloquet, F. Fraysse, S. Dong, S, N. Janot, G. Echevarria, E. Montargès-Pelletier, *The influence of organic complexation on Ni Isotopic Fractionation and Ni recycling in the upper soil layers*, Chemical Geology (2018), 483, 47-55. (IF=3.69).

***3.*** **I.O. Zelano**, M. Malandrino, A. Giacomino, S. Buoso, E. Conca, Y. Sivry, M.F. Benedetti, O. Abollino, *Element variability in lacustrine systems of Terra Nova Bay (Antarctica) and concentration evolution in surface waters*, Chemosphere (2017), 180, 343-355. (IF=4.427).

***4.*** M.Malandrino, A.Giacomino, M. Karthic, **I.O. Zelano**, D. Fabbri, M. Ginepro, R. Fuoco, P. Bogani, O. Abollino, "*Inorganic markers profiling in wild type and genetically modified plants subjected to abiotic stresses* "Microchemical Journal, (2017), 134, 87-97. (IF=2.746).

***5.*** **I.O. Zelano**, Y. Sivry , C. Quantin , A. Gélabert,·A., Maury, K., Phalyvong, K., and M.F Benedetti, *An Isotopic Exchange Kinetic Model to assess the speciation of metal available pool in soil: the case of nickel*, Environmental Science & Technology (2016), 50 (23) 12848-12856. (IF=6.198).

***6.*** **I.O. Zelano**, Y. Sivry, C. Quantin, A. Gélabert, M. Tharaud, S. Nowak, J. Garnier, M. Malandrino, M.F. Benedetti, *Study of Ni exchangeable pool speciation in ultramafic and mining environments with Isotopic Exchange Kinetic data and models.* Applied Geochemistry·(2015), 64, 146-156. (IF=2.82).

***7.*** Z. Ren, Y. Sivry, J. Dai, M. Tharaud,·L. Cordier, **I.O. Zelano**, M.F. Benedetti, *Exploring Cd, Cu, Pb, and Zn dynamic speciation in mining and smelting-contaminated soils with stable isotopic exchange kinetics*, Applied Geochemistry (2015). (IF=2.82).

***8.*** G. Ratié, D. Jouvin, J. Garnier, O. Rouxel, S. Miska, E. Guimarães, Lucieth Cruz Vieira, Y. Sivry, **I.O. Zelano**, E. Montarges-Pelletier, F. Thil, C. Quantin (2015) *Nickel isotope fractionation during tropical weathering of ultramafic rocks*. Chemical Geology (2015) 402,68-76. (IF=3.82).

***9.*** **I.O. Zelano**, Y.Sivry, C. Quantin, A. Gelabert, M. Tharaud, D. Jouvin, E. Montarges-Pelletier, J. Garnier, R. Pichon, S. Nowak, O. Abollino and M.F. Benedetti. *Colloids and suspended particulate* *matters influence on Ni availability in surface waters of impacted ultramafic systems in Brazil*, Colloids and Surfaces A: Physicochemical and Engineering Aspects (2013) 435, 36-47. (IF=2.354).

***10.*** E. Montoneri, L. Tomasso, N. Colajanni, **I.O. Zelano**, F. Alberi, G. Cossa, R. Barberis, *Urban wastes to remediate industrial sites: a case of polycyclic aromatic hydrocarbons contamination and a new process*, Int. J. Environ. Sci. Technol (2013) 11, 251-262. (IF=1.794).

***11.*** C. Quantin, D.Jouvin, A. Gélabert, E. Montarges-Pelletier, Y. Sivry, **I.O. Zelano**, R. Pichon J Garnier,·M.F. Benedetti. *Combining μSXRF, EXAFS and Isotopic Signature to Understand the Ni Cycle in Impacted Ultramafic Soils*. Mineralogical Magazine (2012) 76(6):2259-2262. (IF=3.69).

***12.*** O. Abollino, M. Malandrino, **I.O. Zelano**, A. Giacomino, S. Buoso and E. Mentasti, *Characterization of the element content in lacustrine ecosystems in Terra Nova Bay, Antarctica*, Microchemical Journal (2012) 105, 142-151. (IF=2.212).

***13.*** O. Abollino, A. Giacomino, M. Ginepro, M. Malandrino, **I.O. Zelano**, *Analytical applications of a nanoparticle-based sensor for the determination of mercury*, Electroanalysis 4 (2012) 727,734. (IF=2.817).

## Rapporti scientifici

Deonarine A., Bigalke M., Gfeller L., Neuhaus P., Cloquet C., Zelano I.O., Mestrot A., MerVal: *Tracing heavy metal and methylmercury sources in the Upper Valais, Switzerland*. Final Report to the Environmental Protection Agency of the Canton Valais (2018).

## Articoli inviati per peer revision

**I.O. Zelano**, J. Spangenberg, J. Gonzalez Holguera, J. Pena, *Effect of manganese oxides on organic carbon assimilation and $CO_2$ release by Pseudomonas putida KT2440*. (Inviato a ES&T).

## Articoli in preparazione

**I.O.Zelano** and J. Spangenberg, *Tracing respiration of bacteria fed on microplastics by GC-IRMS***.**

## Parametri bibliometrici

Total publications in peer-reviewed journals: 13

Total citations: 191 (Research Gate)

Average number of citations per publication: 14.69

Total Impact Factor: 39.89

Average Impact Factor per publication: 3.07

h-index excluding self-citations: 8 (Research Gate)

## 6. Attività didattica

### Sintesi delle attività didattica

Il mio contratto di lavoro presso l`Université de Lausanne nel 2019 ha previsto il 20 % del mio tempo dedicato all'attività di insegnamento in Chimica dell'acqua e del suolo. In questo contesto ho assistito la Prof. Pena con attività di lezione frontale, di esercitazione in aula e correzione esercizi:

- Corso « Hydrochimie et pollution des eaux », Licence en Géosciences et environnement, 40 studenti;
- Corso « Biogéochimie environnementale », Master « Environmental Biogeochemistry », 26 studenti.

Sono anche stata implicata nell'organizzazione ed animazione di attività didattica « corso invertito » accompagnando gli studenti nella lettura, sintesi di articoli scientifici e nella restituzione delle nozioni acquisite attraverso la preparazione di presentazioni orali e poster.

### Co-direzione tesi di Laura Magistrale

Durante la mia esperienza di dottorato e post-dottorato ho avuto la possibilita di co-dirigere il lavoro di ricerca di studenti di Laurea Magistrale:

2020 **Co-supervisor** with Prof. Peña of Marie Coudene, *"Potential role of manganese oxides as mediator of organic matter oxidation"* IDyST, Université de Lausanne

2019 **Co-supervisor** with Prof. Peña of Arne Junghans *"Copper pollution in waters, methods for removal and development of a removal-method based on manganses oxide"*, IDyST, Université de Lausanne

2016 **Co-supervisor** with Prof. Pinheiro of Felipe Abbas Da Gama, *"Etude des interactions dans un système ternaire Eu(III)/Matière organique/Argile"*, LIEC, Université de Lorraine

2016 **Co-supervisor** with Prof. Pinheiro of Baptiste Marion, *"Determination of the limits of detection of the nickel in solution with the polarographic method"*, LIEC, Université de Lorraine

2016 **Co-supervisor** with Prof. Pinheiro of Pinotie Coralie, *"Determination of the limits of detection of the nickel in solution with the polarographic method"*, LIEC, Université de Lorraine

2013 **Co-supervisor** with Prof. Sivry of Maury Adeline, *"Etude par cinétique d'échange isotopique (CEI) de la mobilité du nickel dans les sols ultramafiques brésiliens : rôle des phases porteuses"*, Aquatic Geochemistry group, Institut de Physique du Globe de Paris.

2012 **Co-supervisor** of Stage de terrain des étudiants de Master, Institut de Physique du Globe de Paris.

Sono attualmente la principale responsabile di due studenti assistenti al mio progetto di ricerca dedicato allo studio dei residui di plastica dispersi nell'ambiente (Finanziamento Fondation Agassiz e Matterhorn).

# 7. Attività di ricerca

## Research statement

The overall focus of my research concerns the study of molecular-scale reaction mechanisms occurring at solid-solution interfaces between metals, minerals[1], organics[2] and biota[3] (Fig. 1) The comprehension of such chemical and biological reactions is fundamental to constrain the alteration of natural element biogeochemical cycling in response to anthropogenic pressure and to develop remediation strategy.

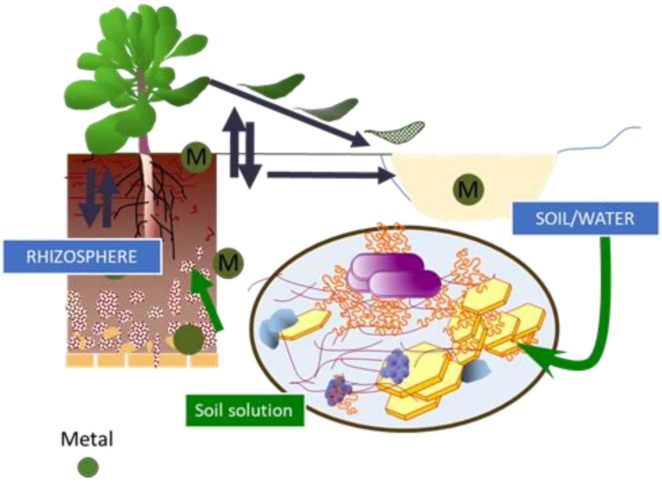


**Figure 1**. Schematic representation of metal biogeochemical cycle in the continuum soil-water-plant system, with specific interactions between soil components: mineral phases, organic substrates, and microbial communities.

## Past and current research activity

At the beginning of my research career, I worked as young scientist to the project "BiochemEnergy" developed by the Department of Applied Chemistry at the Universita` degli Studi di Torino. The aim of the project was the upgrade of biomasses, such as compost, anaerobic digestate and organic residues from mechanical-biological treatment plants, as source of bio-based products for the chemical industry and for agricultural uses[4].

Subsequently, thanks to the development of a wide collaboration network (in Italy, France, Australia, Switzerland,), my work grew around the coupling of the metal isotopic tool to multiple speciation and spectroscopic techniques. This combined approach allowed me to investigate, under environmentally relevant conditions, chemical processes and thermodynamic equilibria regulating metal speciation and mobility in soil systems and surface waters, and to discriminate between different element sources and origins[5,6].

## Doctoral research

During my PhD, in cotutoring between the Universita degli Studi di Torino and the Institut de Physique du Globe de Paris (IPGP), two systems were investigated to study metal biogeochemical cycles: 1) the lacustrine systems in Terra Nova Bay, Antarctica and 2) the ultramafic ecosystems in Goiás, Brazil.

**1.** The mobilization of metals due to human activities is likely to cause, through fine particles and dust transportation, the deposition of metals thousands of kilometres away from their source[7], including Antarctica[8]. During my PhD work, I was interested in discriminating between the natural and anthropic origin of metals in the very remote region of Terra Nova Bay in Antarctica. By using different analytical techniques (optical emission, atomic absorption spectroscopy and high resolution inductively coupled plasma mass spectrometry), the presence of major and trace metals was determined in seasonal lacustrine systems presenting different physical-chemical features. Additionally, algae and mosses were used as biological probes of metal accumulation. Processing new and literature datasets through multivariate chemometric techniques allowed to furnish a range of values that can be considered as a baseline for the studied area and a reference for future monitoring activities[9,10].

**2.** An important part of my research dealt with the study of Ni mobility in surface waters and soils in the ultramafic areas of Goiás State (Brazil). These areas are strongly impacted by mining activity for their richness in Ni and Cr, with consequences on the metal biogeochemical cycling. In this context, an innovative approach based on the use of the stable isotopic dilution (ID) technique was developped[1] to monitoring the alteration of Ni mobility in the mining area. The ID was adapted to kinetic experiments, Stable Isotopic Exchange Kinetics (SIEK), to discriminate between the pool of labile and non-labile metal associated to Ni-bearing minerals (Figure 2). The technique allows the quantification of metal present in exchangeable position ($E_M$) at solid-solution interface. The $E_M$ pool is considered as representative of the bioavailable fraction of metal in soils.

First, the application of SIEK on several typical soil Ni-bearing phases (e.g. smectite, chlorite, serpentine, iron oxides) allowed to characterize the thermodynamic and kinetic aspects of Ni isotopic exchange at solid-solution interface of each investigated phase (Fig. 2). The idea driving this approach was the will of building a model, able to predict the relative contribution of the different mineral phases to the total available pool of Ni[1] in natural samples.

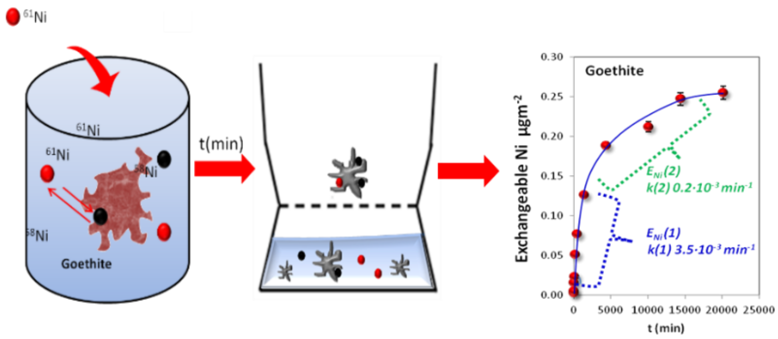


**Figure 2**. Schematic representation of SIEK experiments: $^{61}Ni$ addition (red dots) to goethite suspension containing $^{58}Ni$ (the most abundant natural isotope, black dots) in exchangeable position. The suspension is filtered as a function of time. The isotopic composition in the filtrated is measured by HR-ICP-MS to calculate the quantity of $^{58}Ni$ reacting with $^{61}Ni$. By applying a pseudo-first order kinetic model, we identified two reactive pools at goethite surface with different rate of isotope exchange[1].

Successively, SIEK experiments were conducted on natural soils and suspended particulate matter in surface waters. The coupling of SIEK to Scanning and Transmission Electron Microscopy (SEM, TEM), X-Ray diffraction (XRD) and Ni K-edge EXAFS spectroscopy allowed to *i*) obtain an in-depth description of Ni mobility in natural samples highlighting the relative contribution of the different Ni-bearing phases (Fig. 3) and to *ii*) point out the effect of the dispersion of the anthropogenic Ni-rich ash particles, by-product of metallurgy, on Ni mobility[11,12]. The approach first developed for Ni, was successively applied to study the dynamic speciation of other metals in other mining contaminated soils[13].

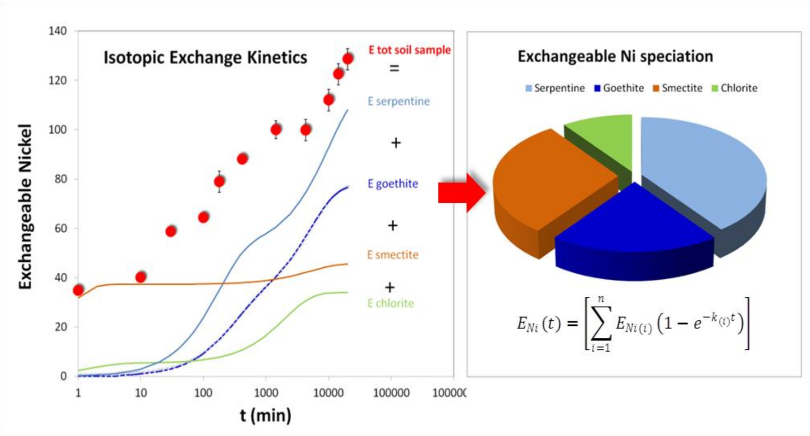


**Figure 3.** Schematic representation of SIEK-model applied to SIEK curve of a soil sample: (left) the lines describe the $E_{Ni}$ kinetics for four mineral phases and the red dots refer to the $E_N$ kinetics in a natural soil sample; (right) the equation used to calculate the contribution of each pure mineral phase to the total Ni exchangeable pool of the soil sample[11].

## Post-Doctoral research

The doctoral experience equipped me with fundamental and experimental skills around Ni geochemistry, thanks to which I was involved as a post-doctoral researcher in the project "Strategic metals in the 21st century" of the Laboratory of Excellence Ressources21 (LabEx), in Nancy, France. My research was based on the use of Ni stable isotopes to *i)* study Ni homeostasis in the hyperaccumulator *Rinorea Bengalensis* used for phytomining and remediation purposes in the ultramafic area of Borneo Island, Malaysia and to *ii)* discriminate between natural and anthropogenic sources of Ni in the environment[5].

*i*) A preliminary investigation of the mechanisms driving Ni isotopic fingerprint in the *soil-water-plant* systems was conducted. First, the Ni isotopic fractionation induced by Ni complexation with purified humic acids (proxy surrogate for reactive soil organic matter) and with small organic acids (i.e. oxalic, citric, involved in Ni plant uptake and storage processes)[2] was assessed by the use of the Donnan Membrane Technique (DMT)[14]. This technique was applied to separate Ni bound to organic ligands from the free metal, before determining its isotopic signature. Obtained results highlighted that Ni binding with carboxylic functional groups produces, in the adopted experimental conditions, a $\Delta^{60}Ni_{bond\text{-}free} < 0.2‰$. This value is not high enough to justify neither metal fractionation later observed between soil and hyperaccumulators, nor the fractionation between different plant parts, e.g. roots and leaves. Conversely, the comparison between specimens suggested an effect of plant age and size on Ni isotopic fractionation in the hyperaccumulator tissues: once Ni is taken up from the soil by roots, it is rapidly transferred to leaves, without being permanently stored there. Instead, it has an active and continuous cycle within the plant through phloem-mediated redistribution. Once the plant has accumulated a substantial quantity of Ni, the isotopic fractionation induced by Ni translocation among aerial plant material is masked by an isotopic homogenization of consecutive internal translocation cycles. Additionally, the Ni isotopic composition measured during leaching experiments of *R. Bengalensis* litter material pointed out that the hyperaccumulators are among the main drivers of Ni isotopic fingerprint in surface layers of the studied area (Fig. 4).

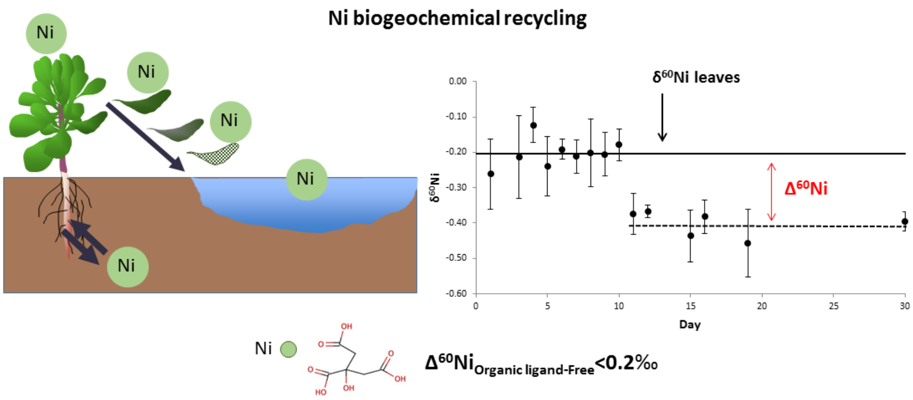


**Figure 4**. Graphical representation of Ni plant recycling (on the left): Ni root uptake from soil, its translocation to leaves and its release to surface layers. Isotopic composition of Ni leached out during leaf degradation experiment as a function of time (on the right). Nickel isotopic fractionation induced by complexation with carboxylic acids (down).

*ii)* By using the isotopic signature of Ni as a tracer of source and processes, I also worked to identify the origin of elevated Ni concentrations found in the agricultural floodplain in Canton of Wallis, Switzerland. This area was highly contaminated after the use of Hg-contaminated sediments, from a chemical plant, as organic-rich fertilizers on agricultural fields and private gardens, and as fill material for roadside construction. While the anthropogenic origin of Hg is known, the high concentration of Ni can be attributed to either industrial processes (Ni could have been used as a catalyst for the production of paraldehyde) or to the presence of serpentine rock formations present in the area[15]. Despite a deep investigation on soil, mineral, water and sediment samples was conducted, the isotopic signature of Ni in the different matrices was not significantly different to discriminate between a natural and an anthropogenic origin of Ni[6].

**Manganese oxide nanoparticles and electron fluxes in bio-organo-mineral composites.** Most recently, I am interested in studying the organo-microbe-mineral aggregates in controlled conditions, representative of soil/water natural systems. These aggregate determine carbon speciation and dictate the balance between organic C mineralized to carbon dioxide ($CO_2$) or stabilized[16]. The sorption of organic compounds on e.g. clay minerals can decrease organic matter oxidation by reducing the contact between extracellular enzymes and the carbon substrates[17–19]. Conversely, strong oxidant minerals, like manganese (Mn) oxides, can increase the pool of accessible C substrates for neighboring microorganisms by promoting the decomposition of high molecular weight organic molecules[20–23]. However, the high reactivity of the minerals could also affect the bacteria metabolism, altering their carbon resource allocation.

Studying glucose metabolism of the typical soil strain bacteria *Pseudomonas putida* KT2440 in presence or absence of $MnO_2$, my current work discriminates between abiotic and biotic reactions responsible for the oxidation of small organic substrates, e.g. glucose. First, by following C oxidation and Mn reduction in the absence of bacteria, we showed that δ-$MnO_2$ reduction involved the accumulation of 35 % $Mn(III)_s$ before mineral dissolution. This finding indicates that $Mn(II)_{aq}$ is not a quantitative proxy for the oxidation of organic compounds, as commonly assumed, and that the lack of $Mn(II)_{aq}$ does not necessarily indicate a catalytic over oxidative role of the mineral[24,25]. Importantly, manganese oxides do not support the complete oxidation of organic molecules to $CO_2$ but instead promote the accumulation of formate in solution[26–28], suitable substrate to fuel microbial respiration and potentially useful in the context of platform chemical. Additionally, by following the rate of production and carbon isotopic signature ($\delta^{13}C$) of the respired $CO_2$ and of the bacterial biomass, the study shows that $MnO_2$ can also shift bacterial carbon allocation to extracellular secretions at the expense of biomass building and push the bacteria in a non-growing state (Figure 5).

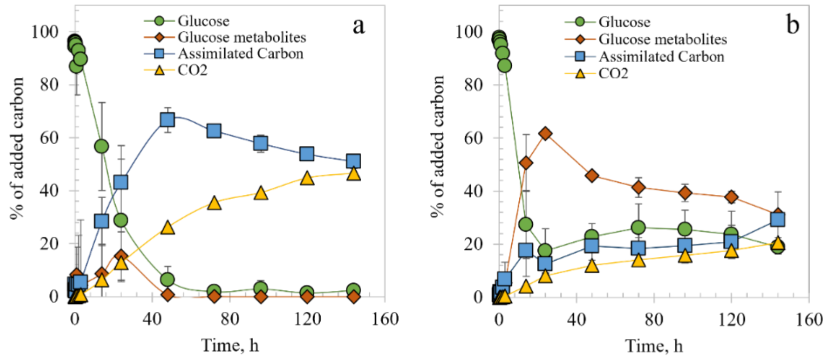


**Figure 5.** Carbon mass balance and speciation after glucose addition in (a) bacteria-only and (b) mineral-biomass composite systems at pH 7 (Zelano et al. Submitted).

Manganese oxides are highly reactive minerals, ubiquitous in a wide range of natural settings. They are among the strongest oxidants in soil and water systems and exhibit a high metal sorption capacity due to their nanometric size, elevated specific surface area and their negative charge under environmental relevant pH values. Because of their peculiarities, the use of Mn oxides nanoparticles is attracting increasing attention as suitable material for in-situ and ex-situ remediation of polluted soil and water systems[46–49]. However, to improve the efficiency of Mn oxides as suitable sorbent for heavy metal remediation, the study of Mn oxides reactivity in organic and metals rich matrices is essential, as well as for assessing the mobility and eventual release of sorbed metals overtime. At present, I am starting a new collaboration with Prof. Boffa for the development of filtration membranes for water polluted systems, using the sorption capacity and the catalytic and oxidative properties of Mn oxides.

**Plastic degradation.** I have recently obtained personal fundings for the development of new project dedicated to study the degradation of microplastic debris exposed to environmental stressors. Currently, almost 80 % of plastic wastes is disposed of on lands or dispersed in the environment, exposing terrestrial ecosystems to extensive plastic pollution. Addressing plastic pollution is, consequently, one of the main goals of the United Nations sustainable development program. In particular, in 2018 the United Nations Environmental Program (UNEP) called for increasing research on microplastics (MPs) in soil environment. I am working at *i)* characterizing the alteration of biodegradable and non-biodegradable polymer surface, after simulated ageing process, by Scanning electron microscopy (SEM), Atomic force microscopy (AFM), Fourier transform infrared spectroscopy (FTIR), laser direct infrared imaging (LDIR); *ii)* characterizing polymer degradation products by High performance Liquid chromatography-mass spectrometry HPLC-MS; *iii)* quantifying the change in metal sorption capacity after ageing; *iii)* quantifying the respiration of typical soil bacteria when fed with plastic polymers by GC-IRMS. I am working on this subject developing new collaborations with the University of Lausanne and the École polytechnique fédérale de Lausanne, thanks to the obtained fundings from Agassiz Foundation and Matterhorn Grant.

Being extremely sensible to the current environmental concerns and challenges, I would be particularly interested in taking part to the project dedicated to the preparation of new colloidal metal nanoparticles and nanomaterials for remediation strategies. Relying on my background in analytical chemistry developed through my past and current experiences, I believe that my expertise could relevantly be applied to these objectives and would allow me to perfectly integrate the Analytical and Environmental Chemistry section of the University of Camerino.

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