



NEWSLETTER N°9 - LabEx RESSOURCES21 - MAY 2020

Geology Ore genesis Exploration	Ore processing Hydrometallurgy	Agromining	Ecotoxicology Environment Remediation	Mines & society: Territorial & economic integration	Recycling

LabEx RESSOURCES21 EXTENSION

Over the last ten years, LabEx RESSOURCES21 strongly contributed to structuring research activities at Université de Lorraine in the field of mineral resources by funding research programs, and more especially two major projects dedicated to the study of the geochemical cycle of nickel and rare earths. These programs enabled the implementation of an original and holistic approach covering ore-deposit formation, ore processing, and metal dissemination in natural environment with a special focus on ecotoxicity. High-quality and original studies performed by the LabEx researchers and lecturers have played a key role in the renewal of the LabEx for the next five years. During this new period, the LabEx will focus its efforts on the development of two new research programs dedicated to investigate the geochemical cycle of gold in French Guiana, and lithium by a multi-focus approach including the challenges of our near-future i.e. societal, territorial, environmental and technological. This new stage of LabEx RESSOURCES21 has opened in February 2020 with researchers from the BETA, LRGP and IJL laboratories joining the taskforce of the LabEx RESSOURCES21.

RECRUITMENTS

Khalifa Eldursi has arrived in January for 16 months at the GeoRessources Lab for working on «Thermo-Hydro-Mechanical Process Modeling (THM) in the context of discordance-type mining deposits - Application to the Athabasca Basin». This project is supervised by As. Pr Luc Scholtes, As. Pr Marianne Conin, Dr Julien Mercadier, As. Pr Pauline Collon and As. Pr Fabrice Golfier.

After his master degree in Ghana, **Allen Fosu** joined the LabEx RESSOURCES21 in January 2020 for a joint-PhD with Université de Lorraine and University of Queensland. His PhD work will focus on the development of an advanced chloride route for lithium extraction from spodumene ores under the co-supervision of Pr Alexandre Chagnes and Pr James Vaughan.

2019 PhD THESIS DEFENCES



Nicolas Grosjean defended on June 26, 2019 his PhD thesis entitled « Study of genes' response to REE in model organisms ». This project financed by LabEx RESSOURCES21 was carried out under the supervision of Pr Elisabeth Gross and Dr Marie le Jean.



Yann Foucaud defended his PhD thesis on December 26, 2019 realised under the supervision of Pr Lev Filippov and Dr Inna Vladimirovna Filippova. This work was entitled « Synergistic effects of reagents with different molecular structures in the flotation of low separation contrast tungsten ores».

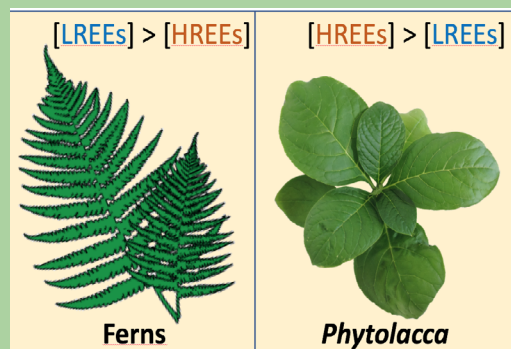


Eleonora Carocci defended on December 13, 2019, her PhD thesis entitled « Tungsten transport and deposition in magmatic-hydrothermal environments: the example of Panasqueira (Portugal) ». This work was supervised by Dr Michel Cathélineau and Pr Laurent Truche.

FOCUS ON RECENT PUBLICATIONS

Accumulation and fractionation of rare earth elements are conserved traits in the *Phytolacca* genus

A few plant species are known to accumulate rare earth elements (REEs). However, the previous studies based on in situ plant samples describing REE fractionation and REE transfer to plant shoots suffered from the lack of homogenous concentrations in the soil. In two studies (Grosjean et al., 2019; Grosjean et al., 2020), we screened for REE uptake and accumulation traits in a large set of ferns and *Phytolacca* species in the presence of equimolar concentrations of the whole set of REE species. The REE accumulation trait was conserved in the *Phytolacca* genus



whereas it was not in most of the fern genera. Moreover, ferns accumulated more light REEs (LREEs) than heavy REEs (HREEs) whereas the opposite conclusion was found for *Phytolacca* species.

Grosjean N, Le Jean M, Berthelot C, Chalot M, Gross EM, Blaudez D (2019) Accumulation and fractionation of rare earth elements are conserved traits in the *Phytolacca* genus. *Scientific Reports* 9: article 18458. DOI: 10.1038/s41598-019-54238-3.

Grosjean N, Blaudez D, Chalot M, Gross EM, Le Jean M (2020) Identification of new hardy ferns that preferentially accumulate light rare earth elements: a contrasted trait within fern species. *Environmental Chemistry* (in press) DOI: doi.org/10.1071/EN19182.

Time-dependent hormesis and differential toxic effects systematically induced by Rare Earth Elements in *Escherichia coli*.

Although the effects of some REEs on bacteria have been previously studied, our work reports for the first time a comparative analysis of *E. coli* exposure to the 16 REEs, in a time and concentration-dependent manner.

Our work reports an overall higher toxicity of the heavy REEs over the light ones, except for the non-lanthanide scandium, which appeared to be the most toxic. The exposure to the lowest doses tested induced a systematic time-dependent hormetic effect for all the REEs. Indeed, a higher bacterial biomass was produced at the stationary phase under low REE treatment over the control.

Also, we reported the cytotoxicity of representative REEs at their EC50 through lipid peroxidation and membrane disorganization, together with an ATP production impairment.

Técher D, Grosjean N, Blaudez D, Sohm B, Le Jean M (2020) Not merely noxious? Time-dependent hormesis and differential toxic effects systematically induced by Rare Earth Elements in *Escherichia coli*.

Environmental Science and Pollution Research 27, 5640–5649. DOI: doi.org/10.1007/s11356-019-07002-z

The use of cyanide in gold extraction

Ottone Scamacca co-wrote an article with Philippe Marion on the use of cyanide in gold extraction, published in *The Conversation France*.

Protests over the Montagne d'Or mining project in French Guiana have put the spotlight back on gold processing in France and around the world. The article provides a factual introduction to the issues and risks associated with cyanide and other products used in gold mining. The article was quoted by some French Guianese actors, notably Jeunesse Autochtone de Guyane (JAG) or the collective «Or de Question,» opposing the Montagne d'Or project.

<https://theconversation.com/pourquoi-utilise-t-on-du-cyanure-pour-extraire-lor-122670>

Recent advances on electrodialysis for the recovery of lithium from primary and secondary resources

S. Gmar, A. Chagnes, “Recent advances on electrodialysis for the recovery of lithium from primary and secondary resources”, *Hydrometallurgy* 189, 105124 (2019).

This article reviews the use of electrodialysis for the recovery of lithium from ores and spent lithium-ion batteries, and the challenges associated with the emergence of this technology in hydrometallurgical processes. <https://www.sciencedirect.com/science/article/abs/pii/S0304386X19303421>

Investigation of leaching mechanism of NMC 811 by hydrochloric acid for recycling cathodes in Lithium Ion Batteries

W. Xuan, A. Otsuki, A. Chagnes, «Investigation of leaching mechanism of NMC 811 (LiNi_{0.8}Mn_{0.1}Co_{0.1}O₂) by hydrochloric acid for recycling cathodes in Lithium Ion Batteries”, *RSC Advances* 9, 38612–38618 (2019).

This paper highlights the mechanisms leading to the hydrochloric acid leaching of NMC 811 which is a positive electrode material for lithium-ion batteries with interesting electrochemical properties and which has the advantage of containing less cobalt than other electrode materials currently in use (reducing the need for cobalt in battery production).

<https://pubs.rsc.org/en/content/articlepdf/2019/ra/c9ra06686a>

FOCUS ON RECENT PUBLICATIONS (Next)

Simulation of solvent extraction flowsheets by a global model combining physicochemical and engineering approaches

A. Chagnes, "Simulation of solvent extraction flowsheets by a global model combining physicochemical and engineering approaches – Application to cobalt(II) extraction by D2EHPA", *Solvent Extraction and Ion Exchange*, 38(1), 3-13 (2020).

This paper presents a global model combining a physicochemical model describing the physicochemistry of the liquid-liquid extraction of cobalt in a chloride environment and a process model for describing the efficiency of liquid-liquid extraction processes as a function of the operating conditions implemented in the mixer-settlers. The combination of these two models enabled the construction of a simulation tool able to calculate the performance of liquid-liquid extraction processes depending on the pH, the flowrates of the different aqueous and organic phases, the extracted concentration and the configuration of the mixer-settlers in the process diagram.

<https://www.tandfonline.com/doi/abs/10.1080/07366299.2019.1691135>

ARTICLES

Groulier P.A., Turlin, F., André-Mayer A.S., Ohnenstetter D., Crépon A., Boulvais Ph., Poujol M., Rollion-Bard C., Zeh A., Moukhsil A., Solgadi F., El Basbas A. (2020) Silicate-carbonate liquid immiscibility: insights from the Crevier alkaline intrusion (Québec). *Journal of Petrology*, in press

Romero-Freire A., Turlin F., André-Mayer A.S., Pelletier M., Cayer A., Giamberini L. (2019) Biogeochemical Cycle of Lanthanides in a Light Rare Earth Element-Enriched Geological Area (Quebec, Canada). *Minerals*, 9, 573.

Turlin F., Vanderhaeghe O., Gervais F., André-Mayer A.S., Moukhsil A., Zeh A., Solgadi F. (2019) Petrogenesis of LREE-rich pegmatitic granite dykes in the central Grenville Province by partial melting of Paleoproterozoic-Archean metasedimentary rocks: evidence from zircon U-Pb-Hf-O isotope and trace element analyses. *Precambrian Research*, 327, 327-360.

Ruoyu Hu Alexis De Junet, Thierry Beguiristain, Corinne Leyval (2018) Transfer mechanism of rare earth elements (REEs) from soil to plants by arbuscular mycorrhizal (AM) fungi. International Workshop on Rare Earth Elements supply: challenges and perspectives, Nancy, 9-11 october 2019.

Thierry Beguiristain, Carole Cossu-Leguille, Ruoyu Hu, Hermine Huot, Coline Lamarche, Ludovic Faravel, Anthony Garnier-Laurent, Alexis De-Junet, Yetao Tang, Chunmei Zhao, Rongliang Qiu, Laure Giamberini and Corinne Leyval (2019) Ecological tests on ionic REE mine tailings. International Workshop on Rare Earth Elements supply: challenges and perspectives, Nancy, 9-11 october 2019.

Ruoyu Hu Alexis De Junet, Thierry Beguiristain, Laure Giamberini, Corinne Leyval 2019 Toxicité et transfert de terres rares du sol aux plantes : rôle des champignons mycorrhiziens. 4èmes rencontres nationales de la recherche sur les sites et sols pollués, 26-27 nov 2019, Paris

Belissant R., Muñoz M., Boiron M.C., Luais B., Mathon O., 2019, Germanium crystal chemistry in Cu-bearing sulfides from Micro-XRF mapping and micro-XANES spectroscopy. *Minerals*, 9-4, 227.

Choulet F., Richard J., Boiron M.C., Dekoninck A., Yans J., 2019, Distribution of trace elements in willemite from the Belgium non-sulphide deposits. *European Journal of Mineralogy*, 31, 983-997.

El Korh, A., Deloule, E., Luais, B., Boiron, M.C., Bastian, L., Vigier, N. 2019. Lithium behaviour and isotope fractionation during fluid-rock interactions in Variscan oceanic suture zones: Limousin ophiolite and Ile de Groix high-pressure terrane (France). *Journal of Petrology*; doi: 10.1093/petrology/egz060

El Korh A., Boiron M.C., Cathelineau M., Deloule E., Luais B., 2020, Tracing metallic pre-concentrations in the Limousin ophiolite and Variscan granites (French Massif Central). *Lithos*, 356-357, doi.org/10.1016/j.lithos.2019.105345

HIGHLIGHT ON OUR INTERNATIONAL COLLABORATIONS



In August 2019, after the signature in Brisbane of the global research cooperation agreement between the Université de Lorraine and the University of Queensland by the respective presidents of each university, LabEx RESSOURCES21 initiated its first year of official cooperation with the Sustainable Minerals Institute (SMI) under the label «SUCRE» Sourcing Unconventional

Critical Research Elements. We thus welcomed in January 2020 the first «SUCRE» PhD student, Allen Fosu, who will share the time of his 3 year-doctoral research project on «Advanced chloride route for lithium extraction from spodumene ores» between Nancy and Brisbane.

AWARDS



The "top peer reviewer prize" 2019 has been awarded to Dr Ndu Kanari, a research engineer in the Resource and Waste Recovery team of the GeoResources laboratory, attributed by the Web of Sciences Group and Publons. Congratulations!

CURRENT POSITIONS OF FORMER RESSOURCES21 PHD STUDENTS


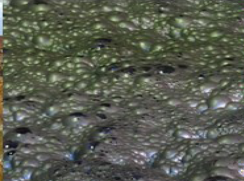
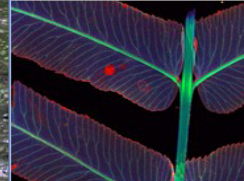



Name	Current occupations after RESOURCES21	Work period for the LabEx	Project title	Supervisors
Rémi Belissont	Research and development engineer ARCELORMITTAL Lorraine, FRANCE	2012-2015	Germanium and related elements in sulphide minerals: crystal chemistry, incorporation and isotope fractionation	Dr Marie-Christine Boiron & Dr Béatrice Luais
Maxime Faivre	Postdoctoral at the University of Minnesota Twin cities, USA	2012-2016	Hydro-geomechanical modeling of fault networks impacted by stress-state changes	Dr Fabrice Golfier & Dr Richard Giot
Jennifer Andrei	Teacher in private school preparing for medical studies Bordeaux, FRANCE	2012-2015	(Sub)individual and functional effects of nanoparticles on freshwater Crustaceans Gammaridae	Dr Sandrine Pain Devin & Pr François Guerold
Matthieu Harlaux	Assistant Professor at the University of Nevada, Reno UNR · Nevada Bureau of Mines and Geology, USA	2013-2016	Late orogenic tungsten mineralization and associated rare metals in the West European Variscan belt: example of the French Massif Central deposits	Dr Michel Cuney & Pr Christian Marignac
Gaëlle Mollex	Primary school teacher in Auvergne, FRANCE	2013-2017	Genesis, evolution and alteration of carbonatite magmas	Dr Lydéric France
Damien Parrello	Postdoctoral position at the University of Dakota, USA	2013-2014	Using genetically modified bacteria, identification of biotic and abiotic parameters controlling Ni mobility	Dr Christian Mustin
Emilie Perrat	Looking for a position	2013-2017	Environmental impacts of Gadolinium-based contrast agents: local situation, cellular and in vivo approaches	Dr Marc Parant & Dr Carole Cosu-Leguille
Pablo Mejia-Herrera	Senior Consultant at MIRA Geoscience in Vancouver, British Columbia, CANADA	2014-2015	Ore-deposits modeling and improving their understanding with structural restoration	Dr Jean-Jacques Royer
François Turlin	Postdoctoral position at University of Geneva, UNIGE · Department of Earth Sciences, SWITZERLAND	2014-2017	Light rare-earth elements enriched pegmatitic granites as tracers of crustal growth and differentiation processes: example of the Proterozoic Grenville Province, Quebec	Pr Anne-Sylvie André-Mayer
Andrei Myacky	Postdoctoral fellow at the Université de Grenoble, FRANCE	2014-2018	Mineralization of Nickel in saprolitic ore of New Caledonia: Dynamics of metal transfer and modeling of coupled geochemical and hydrodynamic processes	Dr Fabrice Golfier
Nicolas Grosjean	Postdoctoral position at the BrookHaven National Laboratory, New York, USA	2015-2018	Study of genes' response to REE in model organisms	Dr Damien Blaudez
Yann Foucaud	CEA/The French Alternative Energies and Atomic Energy Commission (l'Institut de Chimie Séparative de Marcoule (ICSM), UMR 5257)	2016-2019	Synergistic effects of reagents with different molecular structures in the flotation of low separation contrast tungsten ores	Pr Lev Filippov

CURRENT POSITIONS OF FORMER RESSOURCES21 POSTDOCTORAL FELLOWS

Name	Current occupations after RES-SOURCES21	Work period for the LabEx	Project title	Supervisors
Dr Asfaw Zegeye	CNRS Researcher - LIEC, Université de Lorraine, FRANCE	2012-2013	Bio-Reduction of Metal-substituted Iron Oxides: A Mechanism for Metal Remobilization	Dr Christian Mustin
Dr Marc Ulrich	Lecturer – Université de Strasbourg, FRANCE	2012-2013	Geochemistry and Mineralogy of Scandium in Laterites	Dr Michel Cathelineau
Dr Nicolas Estrade	Postdoctoral fellow - University of British Columbia, CANADA	2012-2013	Optimizing nickel phytomining: use of isotope fractionation to better understand soil to hyperaccumulating plant transfers	Dr Christophe Cloquet & Dr Thibault Sterckeman
Dr Véronica Gonzales Andres	University of Almeria, SPAIN	2012-2014	Transfert et dissémination des éléments rares et des terres rares dans l'écosphère : mécanismes, impact écotoxicologique et stratégies de remédiation	Pr Laure Giamberini & Dr Corinne Leyval
Dr Jennifer Mabry	Senior Lab. Tech. International Atomic Energy Agency, Vienna, AUSTRIA	2013-2014	Analyses gaz rares et développement liés au projet datation potassium Argon	Dr Christian France Lanord & Pr Bernard Marty
Dr Antony Van der Ent	ARC Postdoctoral research fellow at the University of Queensland, Brisbane, AUSTRALIA	2014-2015	Agromining of Ni in tropical Ni mine environments	Pr Jean Louis Morrel & Pr Guillaume Echevarria
Dr Ritech Mishra	NASA Johnson Space Center, Houston, USA	2013-2014	Developing high precision, isotope measurement with ion probe IMS 1270 et ims 1280HR2	Dr Marc Chaussidon
Dr Afifé El Korh	Lecturer University of Fribourg, SWITZERLAND	2014-2015	Mobility of metallic trace elements in the Limousin ophiolite massifs: implication for fluid-rock interactions signatures and concentration processes	Dr Etienne Deloule, Dr Marie-Christine Boiron, Dr Béatrice Luais
Dr Thomas Boulesteix	Postdoctoral position at UNAM, MEXICO city	2014-2017	Development of a K-Ar laboratory for the dating of clays	Dr Christian France-Lanord, Dr Michel Cathelineau & Mr Pascal Robert
Dr Laetitia Minguez	CNRS Researcher LIEC, Lorraine, FRANCE	2016-2017	An integrated approach to the ecotoxicity assessment of nickel and other metals in aquatic organisms: A case study at Lake Ohrid (Albania)	Pr Laure Giamberini & Pr François Guérol
Dr Rémi Belissant	Research and development engineer ARCELOR MITTAL Lorraine, FRANCE	2016-2017	Experimental study of Ge isotopic fractionation in sphalerite	Dr Marie-Christine & Dr Béatrice Luais
Dr Ana Romeiro Freire	Postdoctoral position at Spanish National Research Council, SPAIN	2016-2017	Predicting and understanding Rare Earth Element (REE) effects at the sediment-water interface	Dr Davide Vignati

CURRENT POSITIONS OF FORMER RESSOURCES21 POSTDOCTORAL FELLOWS (Next)

Dr Charlotte Berthelot	Engineer at CTIFL Paris, FRANCE	2017-2018	Use of Bacterial biosensor to access the bioavailability of Rare earth elements in environmental samples	Dr Patrick Billard
Dr Gauthier Laurent	Lecturer at Université d'Orleans, FRANCE	2015-2018	Modélisation du transport réactif et des transferts de masse et de chaleur sur des modèles structuraux complexes	Dr Guillaume Caumon
Dr Yoram Teitler	Postdoctoral at CRE-GU, FRANCE	2016-2019	Database	Dr Michel Cathelineau
Dr Ruben Rosenkranz	<i>To be updated</i>	2018-2019	Use of detrital thermochronology on the erosion history of the Himalayas.	Dr Raphaël Pik
Dr Sushanta Kumar	Researcher at CSIR-National in the ECO lab in Jamshe-dpur, INDIA	2018-2019	HydroVAL platform: valuation of metals contained in Iranian residues	Pr Alexandre Chagnes
Dr Alba Otero-Farina	Researcher at the School of Earth and Environment, University of Leeds, ENGLAND	2018-2019	Ecotree/Speciation	Pr Laure Giambérini & Dr Davide Vignati
Dr Cécile Baudouin	Looking for a position	2018-2019	Genesis and evolution of the main rare earth deposits: carbonatites	Dr Lydéric France

Geology Ore genesis Exploration	Ore processing Separation Geometallurgy	Agromining	Ecotoxicology Environment Remediation	Mines & society: Territorial & economic integration	Recycling
					
GeoRessources CRPG	GeoRessources Steval	LSE Coll LRGP	LSE LIEC	GeoRessources BETA	GeoRessources (Steval, Hydroval)
7 LABORATORIES					

International research and teaching collaborations with research institutes:

CANADA (Quebec: UQAT, DIVEX, INRS) CHINA (ECOLAND: international research partnership with Sun-Yatsen university)
AUSTRALIA (UQ, SMI: international research partnership SUCRE)

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