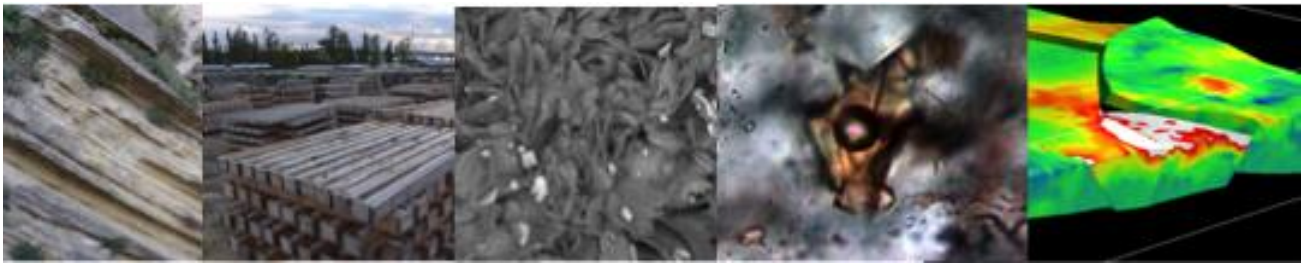

International workshop « Basins and Resources »
40th anniversary of CREGU
13-15 November, 2019,
Amphitheater 8 – Faculty of Sciences – Vandoeuvre les Nancy

Program of the conference

Wednesday, 13th November 2019

8h30 - Welcome to the workshop - Registration
9h00 - Welcome addresses from CNRS, Université de Lorraine, TOTAL and ORANO
9h30 - Introduction to the meeting by P. Landais, Haut Commissaire (Atomic energy Commission) : Ideas and tools for the transfer of scientific results to industry

Session 1 : Fluid-rock interactions : paleofluid characterization and dating
Session dedicated to new and innovative results about fluid and mineral chemistry, dating and P-T-x reconstructions
10h - Keynote lecture - *Girard J-P.* (TOTAL) : Challenges and tools to investigate paleo-fluids in sedimentary basins and reservoirs
10h30 - Tarantola A. : CF-IRMS analysis of hydrogen isotopes in fluid inclusion water
10h45 - Mangenot X. : Clumped isotope composition of CH4 released by crushing methods from quartz of the external part of the Central Alps (Switzerland)
11h - Lahfid A. : The use of the RSCM geothermometry to study the thermal anomalies of ore deposit environment
11h15 - Keynote lecture - *Mercadier J.* (GeoRessources) : New methodological developments to solve dating problems of the world-class U deposits from the Athabasca Basin (Saskatchewan, Canada)
11h45 - Stein H.: Re-Os for Resource Geology - The Unifying Dimension of Time and the Interrogator of Internal-External Fluids in Basins
12h - Blaise T. : In situ LA-ICP-MS U-Pb dating of fluorite

12h15 Lunch offered by CREGU

13h30 - Godeau N. : U-Pb dating of diagenetic carbonates and thermal history of presalt Kwanza basin reveal a major and early pulse
13h45 - Brigaud B. : U/Pb dating and $\Delta 47$ temperature determination of Jurassic carbonates : implications for early and burial diagenesis within intracratonic sedimentary basins
14h - Barbarand J. : Fluid circulation constrained by thermochronology
14h15 - Deloule E. : Effect of Radium mobility on the U-Pb systematic and age determination of U-minerals - the Kazakstan roll front deposits

Posters

Hannah J. : Redox sensitive metals - recorders of fluid and metal sources and transport in sedimentary basins

Le V.H. : New calibration data for determination of PVX properties of CO2-CH4-N2 gas mixtures by Raman spectroscopy. Application to natural fluid inclusions

Session 2 : Fluids and metal deposition: case studies

14h30 - Keynote lecture - *P. Ledru* (ORANO-Canada) : Are footprints critical elements for the exploration of unconformity-related U-deposits ?

15h00 - Keynote lecture - *M. Hitzman :* (ICRAG-Centre, Ireland) New tools provide new insights into the structural and tectono-stratigraphic controls and genesis of base metal mineralization in the Irish Lower Carboniferous

15h30 Coffee break

16h - Grosjean M. : In-situ Cu-isotope systematics of the Copperbelt (DRC, Zambia): variations at different scale

16h15 - Cathelineau M. : Brine-regolith interactions, a key for metal extraction and re-deposition near unconformities

16h 30 - Essarraj S. : Atlasic sedimentary basins as a source for brines at the origin of the Moroccan silver-base metal deposits

16h45 - *Bastrakov E. :* An Integrated Perspective on Sediment-hosted Base Metal Mineral Systems : From Lithospheric Architecture to Fluid Chemistry

17h00 - *Grebenkin N. :* Uranium metallogeny of the late Precambrian framing of the southern part of the Siberian Craton

Posters

Bonhoure-Kafi J. : The manganese deposits of the Franceville Basin, Gabon

Wafik A. : The Skouraz banded iron formation, Bou Azzer inlier, Central Anti-Atlas, Morocco : implication on fluid circulation and metal deposition

Michels R. : Geochemical characteristics of kerogen in Kupferschiefer : relationship to the mineralisation process

17h30 -19h Poster session with refreshments

Thursday, 14th November 2019

Session 3 : Fluid circulations and geodynamics: the example of the Pyrenees
Session dedicated to results about « fluids and faults » in the context of the Pyrenees mountain range, presenting works done at CREGU and in other research centres

8h30 - Keynote lecture - *Y. Lagabrielle* (Geosciences Rennes) : Peridotite - crust- sediments interactions in the frame of mantle exhumation. The Pyrenees in Cretaceous times
9h - Keynote lecture - *E. Gaucher* (TOTAL) : Fluids and water-rock interactions: A synthesis in the W-Pyrenean Foothill basin
9h30 - Boiron M. C. : Paleo-Fluid circulation in the Pyrénées during extensional tectonics
9h45 - Boulvais P. : Stable isotope geochemistry applied to the characterization of fluid-rock interaction during mantle exhumation at rifted margins
10h - Barré G. : Unraveling fluid circulation in western Pyrenees (France)
10h15 - Bahnan A. : Fluid circulation and diagenesis of carbonate reservoirs relative to the geodynamic history of a foreland basin: Example of the Deep Lacq reservoir (Aquitaine basin, SW France)

10h30 - Coffee break

Posters
González Esvertit E. : The Upper Ordovician unconformity in La Molina area (Pyrenees) : Deformation study and formation conditions of the associated quartz veins
Coltat R. : Carbonation of exhumed mantle rocks at rifted margins: insights from Alpine Tethyan analogues
Belkacemi A. : Stratigraphic sequential analysis and oil interest of the upper Silurian - lower Devonian (F6 reservoir) of Southeastern Algerian Sahara : case of Hassi Mazoula field and its bordering regions (Illizi basin - Algeria)
Yensepbayev T. : Paleotemperature and Paleopressure of the Paleozoic rocks of the eastern and southeastern parts of Precaspian basin and the Sakmara zone of Southern Urals based on the study of gas-water inclusions

Session 4 : Roll-front U deposits and In-situ recovery
Session dedicated to ISR of metals (U, Cu, Zn,…) and to research concerning by-product valorisation.
11h - Keynote lecture - *A. Le Beux (ORANO*) : Scientific and technical advances in the field of In situ recovery
11h30 - Rallakis D : The uranium biochemical trap of Zoovch Ovoo: The importance of organic matter
11h45 - Pechenkin I. : Resources of uranium-bearing basins framing the Northern Pamir
12h - Jin R. : Sandstone-type uranium mineralization controlled by the vertical tectonic movements of the Mesozoic and Cenozoic basins in Northern China

12h15 lunch offered by CREGU

13h30 - Keynote lecture - *V. Lagneau (School of Mines, Paris) :* Modeling of Uranium recovery and reactive mass transfer in ISR
14h - Laurent G. : Laboratory and Numerical Investigations of In-Situ Bio-Leaching from Kupferschiefer Copper Ore
14h15 - Noskov M. : Groundwater contamination and self-purification at uranium production by the in situ leaching process

Posters

Eid A. : Clays in sandstones from roll-front deposits exploited by ISR : progresses towards their quantitative distribution using portable tools

Yin C : Sandstone-type Uranium mineralization in North China with its relationship with tectonics and oil/gas reservoir

<u>Session 5</u> : Advances in modelling and subsurface flow simulations

session dedicated to upscaling, implicit modelling of faulted reservoir, THMC modelling,

14h45 - Keynote lecture - *C. Gout (TOTAL) :* Multiscale, multiprocess modeling for sedimentary basin analysis

15h15 Caumon G. : Reproducibility and uncertainty in chronostratigraphic interpretation of subsurface data: why should we care ?

15h30 - Biteau J.J. : Pressures and Petroleum Geology

15h45 - Berthelon J. : Characterizing the Neuquén basin natural fracturing history using basin modeling coupled with 3D geomechanics

16h - Michels R. : Advances in hydrocarbon cracking reactions mechanisms : implication on the modelling of the thermal stability of petroleum in geological reservoirs

16h15 Coffee break

16h30 - Keynote lecture - *Donzé F.V. :* Hydro-mechanical modelling of fault reactivation in low permeability media

17h - Mindel J. and Driesner : Hydrologic mechanisms for interaction of multiple brines from different sources at fractured basement-basin interfaces

17h15 - Weiss P. : Numerical Modeling Constraints on the Formation of Shale-hosted Massive Sulphide (SHMS) Deposits in the Selwyn Basin, Canada

17h 30 - Tiné A-J. : Application of Digital Rock Physics to low-permeability media: issues and challenges

19h30 - Cocktail to celebrate 40th CREGU anniversary
Ferme du Charmois – Vandoeuvre les Nancy

Friday, 15th November 2019

Reservoir and resources

Session 6 : Reservoir and resources

Session dedicated to basins as reservoir or storage for different commodities or materials : Hydrocarbon, H2, H2S, methane, unconventional gas, CO2, nuclear repository,

8h30 - Keynote lecture - *Plas F. (ANDRA) :* Scientific challenges in nuclear waste storage
9h Grgic D. : X-ray tomography applied to self-sealing experiments on argillites
9h15 Tremosa J. : Reconsidering the role of smectite dehydration on overpressures in sedimentary basins
9h30 - Keynote lecture - *Truche L. (ISTerre) :* Hydrogen (H2) migration in sedimentary basins: resource and storage
10h - Fritz B. : A hydro-geochemical modeling approach of possible abiotic hydrogen generation from the granitic basement in the Soultz-sous-Forêts EGS site (Rhine Graben, France)

10h15 Coffee break

10h30 - Sterpenich J. : Annex gases in the geological storage of CO2 : the example of the solubility of NO in aqueous solution up to 600 bar determined by Raman microspectrometry and molecular simulation
10h45 - Bruno J. : Water-rock processes in deep geological storage of wastes and energy : experimental approaches and model predictions
11h - Abuaisha M. : On the validity of the uniform thermodynamic state approach for underground caverns during fast and slow cycling
11h15- *Michels R. :* Dissolved hydrocarbon gases as tracers of solute transfer within a low maturity lithological column of east Paris Basin

11h30 – End of the meeting - Conclusions

14 h- PhD defense by Joséphine GIGON

Dynamics of the McArthur Basin diagenetic/hydrothermal system (Australia): Timing and nature of fluid flow and constraints on the distribution of mineral resources (U, Cu, Pb-Zn)

Jury

Reviewers

M Murray W. HITZMAN Irish Centre for Research in Applied Geosciences, Dublin, Irlande
M Ferenc MOLNAR Geological Survey of Finland, Espoo, Finlande

Examinators

Mme Isabelle DUHAMEL-ACHIN BRGM, Orléans, France
Mme Sophie DECREE Geological Survey of Belgium, Brussels, Belgique
Mme Anne-Sylvie ANDRE-MAYER Université de Lorraine, Nancy, France
M Roger G. SKIRROW Geoscience Australia, Canberra, Australie
M Irvine R. ANNESLEY Université de Lorraine, Nancy, France, directeur de thèse
M Antonin RICHARD Université de Lorraine, Nancy, France, co-directeur de thèse

Invited

M Julien MERCADIER GeoRessources, CNRS, Nancy, France
M Rémy CHEMILLAC Direction des Géosciences, Orano Mining, Courbevoie, France

Abstract

The sedimentary McArthur Basin (Northern Territory and Queensland, Australia) is associated with numerous diagenetic/hydrothermal uranium, copper, lead and zinc concentrations, including some world-class deposits (e.g., Ranger and HYC). Some deposits correspond to styles of mineralisation well defined such as unconformity-type for uranium and Sediment-Hosted Massive Sulphide (SHMS) for lead-zinc, but others are not linked to a specific type. A major mineralising event at around 1650-1600 Ma is recorded in the uranium deposits in the North (Alligator Rivers Uranium Field – ARUF) and South (Westmoreland) parts of the basin and in lead-zinc deposits in the centre (Batten Fault Zone), and accounted for the exceptional metalliferous stock of the basin. In addition, even if it has not been established that the fluids responsible for uranium and lead-zinc mineralisation share a common origin, their characteristics in terms of temperature and salinity are similar. This PhD focused on the major factors controlling metals resources distribution at a large scale in this intracratonic sedimentary basin by studying the mineralisation with a geochronological and geochemical approach, and by characterising the associated fluids in order to define its age, temperature and emplacement conditions.

A synthesis of fluid inclusions and the determination of their noble gas (Ar, Kr, Xe) and halogen (Cl, Br, I) composition indicate that Na-Ca-brines of evaporitic origin and low-salinity fluids probably of meteoric origin have been involved in the uranium mineralisation in the ARUF and the Westmoreland area. This is confirmed by geochemical and isotopic analyses of the Mg-rich tourmaline from the Ranger deposit (ARUF) that link the boron and magnesium metasomatism, a fingerprint of the mineralisation proximal alterations, to the interactions between evaporitic brines and crystalline basement. However, the detailed study of the uranium mineralisation in the Westmoreland area (U-Pb ages, REE content, and chlorite composition) shows emplacement dynamics that are different from the typical processes of unconformity-related deposits in the ARUF, a lower importance of the interactions between mineralising fluids and the basement, and a succession of mineralising events possibly between 1650 and 350 Ma.

The lead isotope composition in galena from different mineralised lenses of the SHMS HYC deposit highlights the implication of two felsic crustal reservoirs as lead sources. These two reservoirs have been synchronously and repeatedly mobilised by hydrothermal fluids around 1640 Ma to form the different lenses. Other deposits or prospects record several younger events (until around 1300 Ma) that involve a mixing between three lead sources. The geochemical signature of the sphalerite and galena from these lead-zinc deposits or prospects states specific emplacement conditions, in particular decreasing formation temperature in the successive episodes (approximately from 220 °C to less than 100 °C).

In addition to the major event at 1650-1600 Ma, the metallogenic history of the basin shows numerous other evidences for crystallisation or remobilisation of the metalliferous stock. Some of the fluid circulation stages are linked with geodynamic events such as basin inversions or orogeneses located a few hundreds of kilometres from the studied area. It seems that the large scale migrations of mineralising fluids (i.e., overall horizontal in the large sandstone aquifers, and vertical in the major faults zones) allowed the metal mobilisation in different reservoirs from the basin and the basement, and their selective precipitation within favourable zones.