INSU - National institute for **earth sciences** and **astronomy**

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ISTO - UMR7327

Earth Sciences Institute of Orléans

The "Institut des Sciences de la Terre d'Orléans" (ISTO) is a research laboratory in Earth Sciences (UMR) with three supervisory authorities (the Université d'Orléans, CNRS, BRGM). ISTO is leading two France-scale excellency projects (VOLTAIRE, 2012-2022; PLANEX, 2012-2019), two of the six platforms of one Région-scale excellency project (PIVOTS, région Centre – Europe), the national observatory "Tourbières", and the 'Val d'Orléans' site of the national observatory Karst.
Our research reaches from Earth's atmosphere and surface to the upper mantle with studies focusing on exchange processes at mantle-crust and crust-atmosphere interfaces. We are organized in five research teams (GP).

Continental Biogeosystems

This GP is interested in the processes that govern the spatio-temporal variability of biogeosystems under climate and / or anthropogenic forces. The research axis quantifies flows and balances in hydrosystems, peat bogs and watersheds, through direct, on-site or paleo-environmental analyses, focusing on Holocene systems. Contaminated sites are under investigation, where mechanisms of interaction between contaminants and lamellar materials are tested. Field observations are combined with the characterization of water / soil / sediment components, and with experimental *(in / ex situ)* and analytical approaches, leading to predictive numerical / mechanistic simulations of how the anthropogenic pressure results in the environmental impacts.

Porous media

The group is working on the relationship between structure and properties within the soil-aquifer continuum. It performs measurements at different scales (critical zone, natural sample, micro-model), in the laboratory and in the field. The targets are the hydrosystems *sensu lato*, which are under anthropogenic pressure through diffuse pollution, and their use as storage for heat, gas or waste, or to extract mineral resources, water or energy. The scientific approach combines experimental simulations and

ISTO building - Géosciences Campus - Orléans © ISTO

Staff

49 researchers (CNRS, BRGM) and research faculty
42 PhD students and post-doctorate associates
28 engineers, technicians, administrative staff

Keywords

Biogeochemical cycles, hydrogeology, paleo-environment, carbon, contaminated sites, on-site instrumentation, reactive transport, multi-scale geological fluids, couplings, tectonics, geodynamics, geochronology, mineral and energy resources, predictive modelling, mass and energy transfer, silicate liquids, volcanism, experimental petrology, thermodynamics.

Incision of the river Jingou (northern piedmont of the Tian Shan) in the continental folds of the Jungar foreland basin © ISTO

Research Training

Degree Courses: undergraduate, graduate and doctoral levels

- Orleans Institute for Earth Sciences and Astronomy
  - B.Sc. in Earth Sciences and Environmental Sciences
  - Master in Earth Sciences, Environmental Sciences and Astronomy

NATIONAL COLLABORATIONS: *INRA, IPG-Paris, IRD, IFP, ANDRA, Besançon (Chrono-Environnement), Clermont-Ferrand (LMV), Grenoble (Isterre), Nancy (GeoRessources, CRPG), Nantes (Subatech), Paris VI (ISTEP, PHENIX), Pau (LFCR, LATEP), Poitiers (IC2MP), Rennes (ECOBIO, Géosciences), Toulouse (EcoLab, GEODE, GET, CESBIO)*
EUROPEAN: *INGV, Palerme, Pise (Italy) ; Institute of Earth Sciences Jaume Almera of Barcelona, CSIC, Grenade (Spain) ; GEUS (Denmark) ; Bayreuth, Berlin, Forschungszentrum Jülich (Germany) ; Bristol, Lancaster, Liverpool (UK) ; Genève (Faculté des Sciences de la Terre), Bern (Institut für Geologie), Lausanne (EPFL), Neuchatel U (Switzerland) ; Liège (Belgium) ; Porto (Geociências) (Portugal) ; Prague (Czech Republic) ; Belgrade (Serbiae) ; Bucarest (Rumania) ; Poznan (Adam Miciewicz University) (Poland),*
INTERNATIONAL: *CSIRO (Mineral Resources) (Australia) ; Universities of Beijing and Nanjing (School of Earth Sciences & Engineering), Shandong and Jilin (China); Lawrence Berkeley National Laboratory (Energy Geosciences division), Princeton (Interfacial Water Group), Easton-PA et Carnegie, University of Washington (USA) ; Montréal (Canada) ; Tokyo (Japan) ; Oslo (Norway) ; Yugra State U, Tomsk (Russia).*

CNRS Regional Office Centre Limousin Poitou-Charentes

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Paterson press for HP/HT, deformation experiments © Didier Depoorter/OSUC

interpretative and predictive modeling allowing unprecedented understanding of coupled mechanisms at the origin of mass and heat exchange between phases at different scales of porous media.

Geodynamics

The GP is interested in the deformation of crustal and mantle materials, from the scale of the lithosphere to that of polycrystalline aggregates, with a focus on processes that localize deformation, and also on fluid-deformation-metamorphism interactions. Questions are addressed through field studies, which describe and quantify the geometry and kinematics of past and present deformation, and by experimental deformation studies seeking to determine the processes at work and their controlling parameters. Field targets (i.e., China, Massif Central, Pyrenees, Mediterranean, Japan) make it possible to define models of geodynamic evolution and rheological behavior, whereas experiments (Paterson and Griggs) and geochronology (Ar-Ar, K-Ar, U-Pb) provide direct quantitative constraints on parameters ranging from strain to time.

Metallogeny and Geo-energies

The objective of the GP is to describe and model transport of metals and energy from source to metallogenic or geo-energy province by targeting magmatic and hydrothermal systems. Studies combine field analysis (geology of hydrothermal deposits), experimentation (reactive transfer autoclaves), and modeling (thermo-kinetic simulation, numerical modeling). Results from these approaches are integrated from the pore scale to the scale of a reservoir or metalliferous province and regions with geo-energy potential. Modelling is used to define deterministic criteria that, combined with advanced statistical methods, provide the basis for predictive approaches to mineral potential and rational management of the energy resources of the subsoil, including storage.

Experimental facilities

Cold-seal (800°C – 3 kbar) and internally-heated (1400°C – 10 kbar) pressure vessels. Piston-Cylinder pressure apparatus (35 kbar - 1800°C). Hydrothermal cells (500°C – 500 bar). Electrical measurements at high-temperature, high-pressure (HT-HP). FTIR and Raman spectroscopy & X-ray absorption coupled to in situ HT-HP cells (1200°C, 2 kbars). HT-HP deformation (Paterson: 1400°C, 3 kbars; Griggs: 1400°C, 40 kbars), with or without fluid circulation.

Ar-Ar and K-Ar age dating. Electron microprobe, LA-ICPMS, SEM-Raman, SEM-EDS/XRF, EBSD, X-ray micro-tomography, X-ray diffractometers, BETmeter, Hg porosimeter, rocks thin section, ultra-thin polishing. Magnetometry.

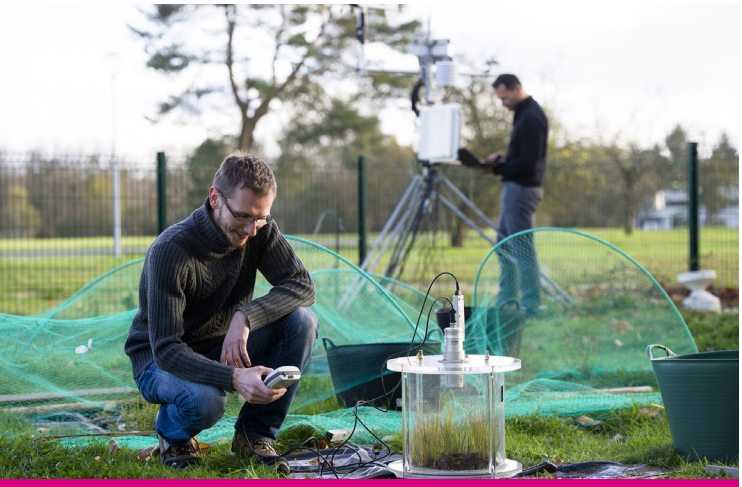
LC-irMS, HPLC, Py-GC-MS, HR-ICP-MS, GC-MS, GC-IrMS, element analyser (CHNS/O and COD/NT), organic petrography, Rock Eval. Oedometry.

Optical microscopy, polarized light, straight and inverted microscopy, metallography, fluorescence. Micro/nano-fluid analysis, with PIV. Micro-thermometry. Micro-Raman confocal, laser IR, spectroscopy PIXE.

Digital cartography, coupled modelling, numerical data processing center.

Magma

The group is working on the magmatic processes from source zones to eruption. Our approach links petrology, geochemistry, and geochronology to the physics of magmatic systems. We use high pressure - high temperature experiments coupled with high resolution physicochemical and isotopic analysis, as well as numerical simulations. Understanding the dynamics of eruptions and magmatic reservoirs, including the transfer of fluids, metals and heat, is a major focus integrating the risk and resource aspects of magmatism. More generally, our work contributes to understanding the role of magmatism in the differentiation of planetary systems (atmosphere, crust, mantle, core) and their secular evolution.



Instrumented site of the National Peatlands Observation Service on the Geosciences campus
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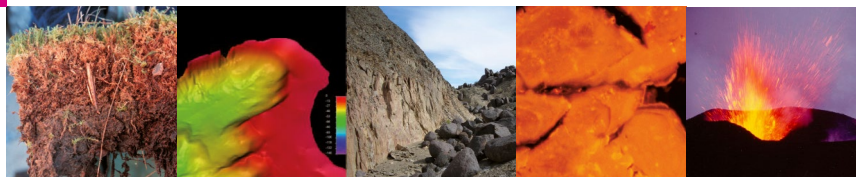

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