POSTDOCTORAL FELLOWSHIP, OPEN POSITION

DATA INTEGRATION AND MACHINE LEARNING TEST BEDS FOR THE CHARACTERIZATION OF THE UNCONFORMITY-RELATED URANIUM MINERAL SYSTEM

The discovery of new large economic ore deposits requires the deployment of different technologies to explore hidden bodies under cover sequences and at depth. The access to large geological, geophysical and geochemical datasets and advances in geographic information system (GIS) technologies to spatially query these datasets have spurred the mineral systems approach. Since that, different data-driven approaches using machine learning and artificial intelligence have given new tools for the geoscientists to explore the distribution of physical and chemical properties in 3D common earth models using 3D explicit and implicit modelling. In this framework, the development of a reproducible data-scientist approach that fully integrates the wide range of complex geological (structure, lithology, mineralogy), geochemical, petrophysical, and geophysical data is a major challenge faced by the exploration companies.

The Orano Industrial Chair “Georesources, exploration and processes” at the University of Lorraine is aimed at promoting new concepts for the exploration of natural resources, including metallogenic guides, new tools and trends in data science and machine learning (spatial statistics, Bayesian analysis, pattern detection). As part of this project, a postdoctoral position is offered at the University of Lorraine to define reproducible workflows to level, process and integrate the data and to evaluate which machine learning methods worked best to define footprints and vectors to mineralization. In accordance with exploration priorities, the focus will be put on the unconformity related uranium mineral system of the Athabasca Basin (Canada). A best practice handbook will be delivered to the project geologists and geophysicists in charge of exploration, identifying the data management, 3D visualization, query and analysis for integration of 3D mineral exploration, interpretation and targeting. The reproducibility of this workflow will be illustrated by at least 3 case studies representing different geological environments for these deposits.

We are looking for a motivated, creative and dynamic candidate. A pre-requisite will be an experience in geoscience data-management, 3D numerical modeling and use of statistical methods for supervised and unsupervised classifications. The work will be carried out mainly at the University of Lorraine in Nancy, in collaboration with geoscientist from the Georessources laboratory and Institut Elie Cartan de Lorraine, in collaboration with Orano Canada and representatives from the MIRA consortium (Canada). The successful candidate will be part of the Georessources Laboratory at the University of Lorraine (http://georessources.univ-lorraine.fr/fr), whose members have a recognized expertise in data-management, 3D numerical modelling and the knowledge of the unconformity related uranium deposits and their physical and chemical properties. Experience in 3D modelling is supported by the RING-GOCAD consortium (https://www.ring-team.org/consortium), led by G. Caumon, who has been awarded in 2019 by the French Academy of Sciences for his researches in numerical geology. Concerning metallogeny, the University of Lorraine is the 1st university in Europe in the 2019 Shanghai classification for mining engineering and mineralurgy and has built through the CREGU a sustainable collaboration with Orano. J. Mercadier is the main scientist within this Laboratory who has a wide expertise in the analysis of the fluid-rock interactions at the origin of the main uranium deposits worldwide. A mathematical support will be provided by R. Stoica, Professor at the University and
member of the Institut Elie Cartan de Lorraine (http://www.iecl.univ-lorraine.fr/) who has a recognized expertise in probabilistic modelling and statistical inference. An additional support will be provided by the MIRA Research Group in Canada which has developed the Geoscience’s INTEGRATOR (https://mirageoscience.com/mining-industry-software/geoscience-integrator/) and is currently developing links with Machine learning tools (unsupervised and supervised learning for targeting), based on an open source code (called Orange, https://orange.biolab.si/).

The main phases of the project will be planned with the support of different specialists and sub-contractors as needed:

- **Integration of geological and geophysical datasets.** The methodology to collect, quality control and interconnect the existing exploration and scientific databases will be formalized in order to ensure the reliability of the modelling stage. This work will be done with the support of data-managers from Orano and University and scientist who have supervised the acquisition and interpretation of data collected in the Athabasca basin. A study in progress through 2 masters, focused on geochemical data from the Athabasca Basin, will serve as a test to build up a preliminary work flow and evaluate best practices for the modelling of geochemical data.

- **Uncertainty in geomodelling.** Evaluating the uncertainty in building the 3D common earth model is fundamental as its construction mixes empirical concepts, sparse observations and measures from drill holes or underground works, and 2 and 3D potential field models derived from geophysical methods. Knowing this condition, each set of data must be carefully analyzed to avoid any bias in the interpretation of exploration results. A specific development will be performed to take into account the structural constrains on the definition of vectors to mineralization.

- **Update and implementation of the different sources of data in a 3D common earth system.** This implementation will be done on 3 selected targets in the Athabasca basin. The selection of these targets will be done in agreement between the Orano Canada project geologists and geophysicists, based on the priorities for exploration, datasets and expected results.

- **Test of different machine learning tool using the Orange open source software, definition of a workflow and know-how transfer to Orano Canada project geologists and geophysicists.**

**Requirements:**

- The candidate must hold a PhD in the geosciences, including 3D modelling and statistical methods or a related science,
- Experience in performing and analyzing experiments with a comprehensive earth system 3D modelling tool,
- Ability and desire to work in a closely cooperating team but also independently,
- Excellent communication skills and good writing proficiency in English,
- Familiarity with coding and running computer models.

**Employment conditions.** The position is starting during 4th quarter 2020. Monthly gross salary will be between 2130 and 4180 euros (exact salary will depend on the experience). The contract is for two years with full French social security benefits (medical insurance, unemployment benefit, pension, maternity leave and child benefit) and with an evaluation after the first year.

**Selection criteria.** Candidates will be evaluated based on their qualifications and ability to fulfill the responsibilities as outlined for this project.

**Deadline for applying.** All applications received prior to September 15, 2020, will be given full consideration. We are looking forward to receiving your application including the following documents: (i) a motivation letter stating research experiences and interests, (ii) a detailed curriculum vitae including a list of publications, (iii) the names, addresses, and telephone numbers of two referees.

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