High Pulsed Power for Rock Fragmentation

Topic proposed *by Ecole des Mines de Paris, Centre de Géosciences*
Main place of work *Fontainebleau, missions in Orléans*
Supervision by *Hedi Sellami (Research Director)*
Isabelle Thenevin and Ahmed Rouabhi (Geosciences/Mines Paris)
12-month fixed-term contract starting as soon as possible
Salary approx. 35k€/year gross

Context:

Pulsed High Power (HPP) generates a strong electrical discharge between two electrodes (up to 600kV), creating a powerful shock wave capable of fracturing solid materials. This technique has a wide range of applications: crushing and grinding of ores, recycling of concrete and waste, fragmentation, and drilling of hard rock, etc. Research conducted at the Ecole des Mines de Paris (EMP) and BRGM has shown that HPPs can be several times more effective at fragmenting hard rock than conventional mechanical methods. They offer an effective, energy-efficient, and environmentally friendly alternative, since their use results in zero gas and noise emissions and reduced dust and waste.

PostDoc program:

The proposed work is part of a larger project conducted in collaboration with several partners. Within the Geosciences team, it currently involves three part-time senior researchers and a PhD student. The work requested of the PostDoc comprises two main components:

- **Component 1**: Analysis of rock fragmentation processes using electro-pulses.

In the field of mineral resource processing, particle size reduction is generally achieved through a combination of crushing and grinding steps, which are the most energy-intensive of the concentration steps (50%) and generate a lot of fines as they are not selective. The HPP method can generate cracks at grain boundaries, rather than randomly as in a conventional mechanical crushing system.

An experimental program is being conducted by BRGM and the Centre de Géosciences de l'Ecole des Mines de Paris, with the aim of gaining a better understanding of the mechanisms involved in the process of electrical fragmentation of rocks, and to lay the foundations for a numerical model of the interaction between the impulse and the rock.

Based on several test results already carried out by EMP and possibly additional experiments, elementary experimental relationships between the volume of rock destroyed by the electric pulse and the intensity of the applied electric field will be sought. In collaboration with the project team, the aim is to carry out a parametric study of the efficiency of the electro-pulse process; this will include the effects of pulse characteristics (voltage, energy), distance between electrodes, electrode configuration, the nature of the fluid in which the rock is immersed (water and bentonite) and finally the nature of the rock.

- **Component 2**: Numerical simulation of the electrical discharge process

The results of Task 1 will be used to establish a database of process performance as a function of rock type, electrical parameters, and test conditions (distances between electrodes, type of fluid, number of pulses, etc.).

The Geosciences team has already established an initial numerical model of the electrical process in a dielectric rock. This modelling should make it possible to predict the "electrical breakdown" of the rock responsible for its mechanical fracture. The PostDoc's task is to analyze the results of this modeling in the light of experimental results, propose improvements and implement them in the numerical model. A model of the coupling between electrical and mechanical processes will be studied to lay the foundations for a future model describing the mechanical fragmentation of rock induced by a strong electrical discharge.

Candidate profile: PhD in electricity and/or mechanics.

Please send your CV and covering letter to

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