

## SUJET DE THESE/THESIS SUBJECT

Impact of tailings on environment: example of transfers of elements from spoil tips in the North of France.

### Context

The exploitation of the subsoil to satisfy human needs and comfort has strong impacts on the environment notably with the generation of large amounts of waste. These “geological” wastes can represent immense amount of material, piled up to form large hills, significantly modifying the landscape and called tailings. These tailing piles are often stored in direct contact with the atmosphere, meteorological waters and the biosphere, thereby submitted to weathering and leaching of their constituted material. Accordingly, potential pollutant/toxic elements can be transferred from tailings to their direct environment causing a risk for the human health and the ecosystems. So, to face up to these social, economic and environmental issues of tailings/environment interactions, the processes of release and transfer of pollutants must be accurately understood to quantify their impact and to minimize it.

In France, this problematic is particularly present in old mining regions and quarries, notably in the North of France which holds one of the largest coal mining area in the country. Although the spoil tips - tailings formed by the residue and wastes of the past coal exploitation - are considered as sterile, we can observe the formation of neo-soil and the colonization by pioneer species at their surface. This makes them original and unique ecosystems in the region which must be protected. But beyond the originality of this kind of systems and the apparent obvious benefit for biodiversity, spoil tips can also be responsible for transfer of potential pollutant/toxic elements originating from the parent geological material (trace metal elements, sulphur, organic compounds, etc.), and transported via surface and subsurface runoff.

### Objectives

This project aims to characterize the spoil tips/water/surrounding environment interaction and transfers, to establish the flow balance of mobile elements, and to identify potential risks of pollution. Thus, we plan to explore three research axes: (1) A geological axis, to characterize the parent geological material and the mineral weathering processes (characterization of the source of transfers of elements), (2) a pedological axis, to investigate the soil formation and to define the role of neo-soil in transfers of elements, and (3) a geochemical axis, to determine and quantify transfers of elements to surface environment. Combining results of these three research axes, we will be able to help in development of strategies for a better management of spoil tips and their ecosystems.

### Strategy

To carry out this project, research will include geological, geophysical, hydrological, ecological and biogeochemical approaches, applied on several selected spoil tips. Several sampling, measuring and analytical protocols are specially developed for this project and have never been applied before on this type of geological object which are spoil tips. Thus, to characterize the weathering processes of the geological material, bulk and nanoscale compositional analyses will be conducted (XRD, SEM, TEM-EDX, STXM-XANES ...). Lab leaching tests will be used to establish links between element release from geological material and neo-soil and the in situ composition of surface runoff and percolating waters.

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**Program:** ANR JCJC Projet ENTRESOL

**Recruitment date:** October, 2021