Evolution of the Crystal Chemistry of Critical Metallic-Bearing Phases Over Time

Georgia Grypaiou Iskenteridou*†[1,2], Alexandra Courtin*‡[1], Erwan Paineau[2], Emmanuel Léger[1], Julius Nouet[1], Amélie Plautre[1], and Menel Bereksi[1]

[1]Géosciences Paris Saclay – Université Paris-Saclay, CNRS, GEOPS, 91405 Orsay – France
[2]Laboratoire de Physique des Solides – Université Paris-Saclay, CNRS, LPS, 91405 Orsay – France

Résumé

Mining operations are essential for extracting valuable resources although produce significant volumes of waste with different mineralogical compositions, as well as various physical and chemical properties. Mining waste can be considered in two ways: as valuable secondary resources or as a potential source of pollution. The remediation of mining residues is always challenging due to the aforementioned issues, the age of the mine heaps - in France, dating back to antiquity and extending to the end of the 20th century - and the widespread distribution of the waste.
Here, we investigate how a non-remediated site (W Leucamp district of the French Massif Central) evolved over time, especially regarding the formation of new minerals after weathering processes of mining waste and their role in natural attenuation strategies.

To address this issue, the hardpans (indurated iron layers) are of high interest as they are considered to be an efficient sink for metal(loid)s. Hardpans are formed from indurated mining waste thanks to the weathering of sulfide-rich phases (mainly As-rich pyrite). In addition to W, other trace elements present in the waste were studied, notably As because of its well-known toxicity, and Bi given the lack of knowledge about its geochemical behavior and toxicity. Moreover, these three elements are classified as critical raw materials.

This work aims to understand the on-site hardpans formation, their role in retaining critical and/or potentially toxic trace elements (long-term efficiency), especially at the sub-micron scale. To this end, a multiscale approach, including synchrotron-based techniques (XRF, XANES), as well as dynamic leaching was employed.
The mineralogical composition of the various wastes present on site was determined, especially hardpans, as well as the fractionation of metal(loid) elements within the mining waste and their evolution over time. The results provide an initial overview of the leaching capacity of trace elements in relation to different solution chemistries. It also gives insights into the weathering of minerals/mineraloïds, the potential acidity generation, and the elemental redistribution toward various environmental compartments in the surrounding area.

Mots-Clés: Mine, Metal(loid)s, Hardpans, Natural attenuation

*Intervenant
†Auteur correspondant: georgia.grypaiou-iskenteridou@universite-paris-saclay.fr
‡Auteur correspondant: alexandra.courtin@universite-paris-saclay.fr