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Authigenic magnetite in soils: pollution fingerprints in a former wolfram mining

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The North of Portugal is particularly rich in metallic mineral resources, whose exploitation dates back to the 19th century. The important amount of mining wastes resulting from the tungsten mining activities deposited in tailing represent a source of pollutants that are emitted, released, or leached to the surrounding environment. It is well documented that improper mining waste disposal will result in air, soil, and water pollution. This environmental legacy, and the contamination caused by the mining waste disposal, is far from being properly assessed, namely the impact on the soils of the surrounding areas. We studied the mining area associated with Regoufe granite where several tungsten-rich deposits occur in and around the granite body, and whose exploitation stopped in the fifties of the 20th century.

In this study, magnetic methods are used to identify ferromagnetic minerals in soils sampled in the surrounding area of Regoufe mine, which serve as tracer for anthropogenic pollutants. We measured the mass specific (χ) and frequency-dependent (Kfd%) magnetic susceptibility and we acquired isothermal remanent magnetization (IRM) curves of eight granitic soil samples from the mining area. Our results show that χ is comprised between 2.82 and 477.20 × 10^{-8} m^3/kg, which indicates that besides diamagnetic and paramagnetic particles, ferromagnetic minerals are present in variable concentrations. Kfd%, which reflects the concentration of superparamagnetic (SP) grains, and particularly those close to the threshold SP – single domain is relatively low and comprised between 1.21 and 2.48%, indicating a very weak contribution of SP particles. IRM curves were treated by a cumulative Log-Gaussian (CLG) and a Skewed Generalized Function (SGG) using the the software developed by Kruiver et al. (2001) and the MAXUnMix software (Maxbauer et al., 2016), respectively. All IRM curves were fitted by using a single component with mean coercivity (B1/2) of 53.7-61.7 mT and DP of 0.27-0.29, typical of fine-grained magnetite. SIRM values are comprised between 1.69 and 14.71 × 10^{-2} Am^2/kg, suggesting that the large variability observed in the values of magnetic susceptibility results from a heterogenous distribution of magnetite among the studied samples. The S-ratio varies between 0.989 and 0.992, indicating that magnetite is the main magnetic carrier of the studied samples. The mean coercivity (B1/2~60mT) of this magnetite population is significantly higher than the typical mean coercivity of pedogenic or detrital magnetite (Egli, 2003). DP of 0.27-0.28 are also lower than the DP values for pedogenic or detrital

magnetite (typically ~0.34-0.36) pointing to the presence of authigenic magnetite resulting from the pollution of the mining waste deposits. More investigation is required to evaluate the extent of the polluted areas and their impacts on the environment.

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