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Biogeochemical characterization of soils affected by more than 100 years of lead mining activity.

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Mining has an adverse effect on soil quality as it is a source of heavy metal environmental pollution with direct consequences on its ecosystem services, especially those related to microbial activity. The magnitude and diversity of the impact produced by pollution is linked to the complexity and diversity of mining processes that share the same mining area. The soil will be modified, not only in the physicochemical characteristics but also physical alterations of varied typology will occur. All these changes and alterations related to mining activity are accompanied by changes in the composition, diversity and activity of soil microorganisms..
A study was carried out on a mine site showing variable degrees of contaminations with metals, to estimate the impact of mining works on the geochemistry of soils, and the activity and diversity of soil microorganisms. The aim is to characterize the level of disturbance on the "soil health" due to the presence of different metals, related physicochemical factors, and typology of the wastes affecting the soil. Besides, the process of bacterial colonization of the wastes has been also subject of interest to our work.
The selected study area was originally a lead-silver mine. Later, a mineral treatment plant was established in the area in order to recover Zn from the primary gangue dumps. In addition spills of olive mill residues were later deposited in the area. Four composite samples from the five distinct sites differing in their characteristics were selected: tailings, dumps, olive mill residues, contaminated soil and reference soil. A range of various analyses was done on these samples including pH, electrical conductivity, organic matter, multi-elemental contents, enzymatic activity and bacterial biodiversity (16S rRNA amplicon sequencing).
Selected sampling sites have contrasted physicochemical characteristics: acidic pH was observed in dumps (3.8 in average) and neutral in tailings and soils (~6); highest conductivity was recorded in dumps (2282 microS cm-1 in average) and lowest in soils (62 microS cm-1 in average); the highest organic matter value was measured in soils amended with olive mill residues (60% in average). Heavy metals were detected in higher concentrations in dumps and olive mill residues than in tailings or soils. It is noteworthy in dump samples the maximum concentrations of metals reach 6.8% with significant amounts of Zn, Cu, Sb, Hg, Ni, Co and Mn. Highest enzymatic activities were measured in contaminated and non-contaminated soils, while lowest values were obtained in dumps and tailings soils, in accordance with the concentration of metal measured in the matrix. Next generation sequencing analysis of 16S rRNA amplicon lead to the discrimination on the

different sites sampled according to bacterial composition and diversity. Most abundant bacterial phyla were Proteobacteria, Actinobacteria, Chloroflexi, Acidobacteria, Gemmatimonadetes, Bacteriodetes, TM7, Firmicutes, Cyanobacteria and Verrucomicrobia.
As a conclusion, we have found evidences of the intense affection of the metal pollution to the microbiological biodiversity, particularly that related with the presence of high Pb concentrations.