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Mercury and other potentially toxic elements in the Sierra Gorda (Queretaro area, Mexico): affection to enzymatic activity in soils.

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Cinnabar mining, to obtain mercury, is still an important activity for the residents of the Sierra Gorda in Mexico, so this activity is currently source of mercury emission and possibly of other potentially toxic elements (PTE). In this work, seven study sites, located in areas with presence of exploitations of active or decommissioned mercury mines, have been studied with the aim of characterizing its occurrence and their effects on soil health.

Biogeochemical analyses have been carried out with the purpose of identifying the key factors related with nutritional and toxicological status of these soils, looking for possible relationships between mercury, PTEs and their impact on the enzymatic activity of the soil.

The values obtained for total mercury ranged from 5 to 159 ppm; comparing these values with those from an uncontaminated area, we observe that all zones are above reference range (0.01 to 0.03 mg/kg) and that four of them exceed the maximum permissible limits (23 mg/kg), according to Mexican regulations. Other measured PTE elements were Pb, with a range between 18.7 to 814.1 mg/kg; Cu between 45.4 to 94.2 mg/kg; Zn between 145.1 to 555.8 mg/kg; As between 30.5 to 1590 mg/kg; and Sb between 18.3 to 169.6 mg/kg. Comparing with other areas, anomalous concentrations of trace elements in soils with the following values are considered: Pb up to 10,000 mg/kg, Cu up to 2,000 mg/kg, Zn up to 10,000 mg/kg and As up to 2500 mg/kg; none of the determined elements exceeds these reference values. In the case of enzymatic activities, a range between 111.36 and 332.38 $\mu\text{gTPF g}^{-1}\text{day}^{-1}$ was obtained with dehydrogenase. These values are slightly higher compared to other Hg contaminated soils (110 $\mu\text{gTPF g}^{-1}\text{day}^{-1}$) described by this team. For the acid phosphatase, a range between 516.72 to 1606.34 $\mu\text{gPNF g}^{-1}\text{h}^{-1}$; and for alkaline phosphatase a range between 1624.92 to 4070.82 $\mu\text{gPNF g}^{-1}\text{h}^{-1}$. These values correspond to those measured in Sokolov, Czech Republic, ranging from 381 to 1510 $\mu\text{gPNF g}^{-1}\text{h}^{-1}$ for acid phosphatase and 455 to 4820 $\mu\text{gPNF g}^{-1}\text{h}^{-1}$ for alkaline phosphatase measured in topsoil layer from spoil heaps after brown coal mining.

Our results show that the soil has contents of PTE elements indicating low pollution degree, except for Hg, registering concentrations above the maximum permissible limits for non-industrial soils; however, the results of the enzymatic activity reflect a "good" activity. Therefore, the incidence of the presence of these metals in the soil health, as measured through enzymatic activity, does not

have a significant impact and the studied soils can be considered as suitable for commercial, residential or agricultural uses.