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Spatial distribution of trace elements and risk assessment in agricultural soils affected by sulphide exploitation in Riotinto (Iberian Pyrite Belt, SW Spain)

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The decadence of mining activity in the Riotinto Mining District (SW Spain) during the end of the last century has led to citrus agriculture as the new social development. This new activity has been carried out around abandoned mines without the assessment of soil pollution. The aim of this work is to study the distribution of potentially toxic elements in soils of the Riotinto mining area and compare them with the element concentration absorbed by plants, in order to assess the potential risk involved in the use of the studied soils, defining also the most dangerous areas for agricultural activities. Twenty-seven agricultural soil samples were collected from the Riotinto area. Major and trace elements were analysed by Inductively Coupled Plasma Optical Emission Spectroscopy (ICP-OES) after 4 acid (HF–HClO4–HNO3–HCl) digestion, except As, Co and Cr that were analyzed by Instrumental Neutron Activation Analysis (INAA). In general, the total concentrations of the trace elements analysed exceeded the background concentration values for Andalusian soils and, on occasions, they surpassed the threshold values defined by percentile 95 for the geological domain of the South Portuguese Zone (Galán et al., 2008). Copper and Zn displayed median values of 99 and 150 mg/kg, respectively, and 44% of the samples surpassed the threshold of 147 and 173 mg/kg for Cu and Zn, respectively. Arsenic reached up to 204 mg/kg and Pb up to 598 mg/kg. The association As-Cu-Pb-Zn and their distribution close the Riotinto waste dumps (NE of the studied area) suggests an anthropogenic origin for these elements. On the contrary, Ni, Cr and Co showed also high values with median concentrations of 41, 113 and 23 mg/kg, respectively, but about 30-48% of the samples were below the baseline values proposed for these elements. The distribution of Fe-Co-Cr-Ni shows they are enriched in the SW part associated to volcanic rocks, which suggests a geogenic origin for them. In order to evaluate the potential risk, the bioavailability was assessed by acidic and EDTA extractions. Copper, Zn and Pb showed a high bioavailability in several samples of the NE part, which involve a high potential risk for agriculture in this zone. On the other hand, Co, Cr and Ni showed a low bioavailability even when they displayed high total concentration in soils. The foliar analysis of orange trees was carried out by ICP mass spectroscopy (ICP-MS), and it showed that not always bioavailable elements were absorbed by plants.

References

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