Metal(loid)s and radioactive metallic elements in the clay-sized fraction of soils used for agriculture in Brava island (Cape Verde)

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Brava is a small volcanic island of the Cape Verde archipelago with an older basement composed of a submarine volcanic sequence (nephelinitic/ankaramitic hyaloclastites and pillow lavas) and an intrusive complex (alkaline–carbonatite) that is unconformably covered by younger sub-aerial volcanic deposits (dominated by phonolitic magmatism). Sediments also occur. Intrusive and extrusive carbonatites increase the imbalance of elements in the parent materials that can impact on the health of plants and animals growing in or on the soils. Brava is characterised by an irregular plateau between 300 and 976 m above sea level, with numerous closed depressions corresponding to recent phreato-magmatic craters. Soils are incipient mainly due to a semi-arid climate. Cultivated land is mostly found in soils developed on phonolitic pyroclasts at the plateau area around Nova Sintra village, where a higher index of moisture occurs, together with soils developed on sediments particularly in fluvial valleys.

A geochemical, mineralogical and iron speciation study of topsoils developed on phonolitic pyroclasts and on sediments is reported, aiming at assessing metal(loid)s behavior, including radioactive elements, and the mineralogical assemblage. Whole samples and the clay-sized fractions were analyzed by neutron activation analysis, X-ray diffraction and Mössbauer spectroscopy.

A general enrichment of the chemical elements studied in the clay-sized fraction of soils is observed, with exception of Fe and Cr suggesting their occurrence in coarser particles of iron oxides; a significant enrichment of Sb occurs in the clay-sized fraction of the plateau soils particularly those close to fault zones. Radioactive elements tend to be concentrated in the fine particles, except in soils developed in sediments with a significant contribution from extrusive carbonatites and from the alkaline–carbonatite complex. Illite, mixed-layered minerals and kaolinite were the main clay minerals identified in the studied topsoils. Chlorite also occurs in trace amounts. Approximately 85% and 75% of the total Fe is in the Fe^{3+} oxidation state in soils developed on sediments and phonolitic pyroclasts, respectively. Hematite is virtually the only Fe oxide present in soils of sediments, while maghemite is more abundant than hematite in soils developed on pyroclasts.