Effective radium concentration of lead-contaminated topsoils

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As the global amount of topsoil is decreasing and its importance for agricultural purposes is increasing, the detection and quantification of metallic pollutions in topsoils has become a topical concern of the utmost importance. Radium, which is generally concentrated in metal oxides and hydroxides and relatively easily leached from rock and soil, could potentially give precious information about the extent of the pollution at large spatial scales. In this study, the radon source term (effective radium concentration, EC_{Ra}) of more than 300 topsoils from a lead-contaminated site in the North of France has been measured using the accumulation technique. After placing the sample in a container, sampling of the air is done using a scintillation flask after some accumulation time. Radon concentration in the flask is inferred from counting in a photomultiplier 3.5 h after sampling, from which the effective radium concentration (EC_{Ra}) of the soil sample is calculated, expressed in Bq kg^{-1}. This technique allows the measurement of large numbers of samples. The EC_{Ra} results of the topsoils, obtained over *ca.* 800 km^2, show remarkable spatial organization and the values are compared with the results of their chemical analyses performed at ISA (Lille, France) and BRGM (Orléans, France). The highly lead-contaminated zone (with Pb concentrations larger than 250 ppm) is also relatively well circumscribed using EC_{Ra} apart. Indeed, EC_{Ra} values of topsoils are larger in the contaminated area than outside, compared with the average regional EC_{Ra} value. The mapping of EC_{Ra} of topsoils at large spatial scale appears therefore as an important asset to characterize this polluted area. Our EC_{Ra} data are also compared with the low-field specific magnetic susceptibility (χ_m) and other magnetic parameters to infer some insights from the magnetic fabrics in the soil and the $EC_{Ra}-\chi_m$ relations. Relations between EC_{Ra} and others metallic elements (Cr, Co, Hg, Ag) or others intrinsic characteristics (amount of sand, silt, organic matter) of the topsoils are also provided. EC_{Ra} appears as a powerful parameter to characterize the spatial structure of soils, and in addition provides clues on the susceptibility to heavy metal contamination. This study opens some interesting perspectives for the understanding of the relation between radium and heavy metals in the environment.