Urban geochemistry of lead in gardens, playgrounds and schoolyards of Lisbon, Portugal: a review

[a]Reis A P, [a]Patinha C, [a]Dias A C, [b]Cave M, [b]Wragg J, [b]Shepherd T J, [a]Ferreira da Silva E, [c]Bartolomeu S, [d]Sousa A J, [e]Batista M J, [e]Prazeres C, [d]Figueira R, [f]Sérgio C

In 2007 a target survey land-use (urban recreational spaces) versus sensitive receptor (children aged 1-6 years) was carried out in Lisbon. From the 51 selected sites, 5 correspond to schoolyards, 19 to playgrounds and 22 to public parks and gardens. Two road-side samples were collected in sites with high traffic density and 3 sites are located at the International Airport of Lisbon, area airport-air. Fifty one topsoil and ground-level dust samples were collected. At each site, 1 uncontaminated moss transplant was fixed to a horizontal tree limb, which remained in situ for 6 months. All samples were dried in a fan assisted oven at <40ºC and sieved to provide the <250 µm soil fraction and <500 µm dust fraction. Total concentrations of Pb were determined by ICP-MS for soil, dust and moss. The bioaccessible fraction was estimated using the Unified Bioaccessibility Method (UBM) and lead isotope analysis were carried out using multi-collector, plasma induced mass spectrometry, for soil and dust. The solid-phase distribution study of the urban soil was carried out using the Chemometric Identification of Substrates and Element Distributions method (CISED), a non-specific sequential extraction. The biomonitors show higher Pb levels in the old part of the city, with a maximum concentration of 75 $mgkg^{-1}$. For dust, the area with higher concentrations is the airport, with values ranging from 259-634 mgkg-1. Lead in soil reaches the higher concentrations also in the old city. Lead isotope analysis of soils and dust show that this element has both geogenic ($^{208}Pb/^{206}Pb$ ratios <2.095) and anthropogenic sources ($^{208}Pb/^{206}Pb$ ratios >2.100), with elevated concentrations of Pb, Cu, Cr and Sb characterising the highest ratios. The two road-side samples and a garden adjacent to a petrol station have isotopic signatures closer to the anthropogenic sources (leaded petrol). The isotopic analysis of dust samples shows similar results. Nineteen soil samples were selected for the bioaccessibility testing. The bioaccessible fraction (Bf) of Pb in the soil raises some concern in terms of public health as it show

values ranging from 24-100% (100% in a school-yard near a highway). The solid-phase distribution study indicates that the main Pb-phase is clay, but carbonates and Al-Fe oxyhydroxides are also important hosts. Only 8 dust samples were used in the bioaccessibility estimation, although ingestion of contaminated dust is also an important pathway of exposure for children. The Bf of Pb in dusts ranges from 35 to 100% and has an average value of 78%. Although the number of samples under study is low, the results indicate that Pb in soils in predominantly in bioaccessible forms. None of the analysed samples correspond to road-side or airport dust, meaning that it is reasonable to assume that exposure through dust ingestion is likely to occur.

[a] *GEOBIOTEC, University of Aveiro, Campus de Santiago, 3810-193, Aveiro, Portugal (pmarinho@ua.pt)*
[b] *British Geological Survey, Nottingham, UK*
[c] *Physics Department, University of Aveiro, Campus de Santiago, 3810-193, Aveiro, Portugal*
[d] *CERENA, Technical Superior Institute, Av. Rovisco Pais, 1049-001, Lisbon, Portugal*
[e] *LNEG, Estrada da Portela, Zambujal, 2720-866 Amadora, Portugal*
[f] *Jardim Botânico – MNHN, Lisbon, Portugal*