Letter to the editor regarding a study of the routes of contamination by lead and cadmium in Santo Amaro, Brazil

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In a recent publication, Machado et al. [1] presented the results of a study conducted to assess the origin of Pb and Cd contamination in the region of the former Santo Amaro primary lead smelter. A numerical simulation of roasting-smelter emissions (SO₂) and refinery emissions (particulate material) was performed, soil samples were collected around the smelter chimney and treated and the Pb and Cd soil content was analysed and correlated with the simulated results. Furthermore, the soil located in homes close to the Santo Amaro smelter, supposedly contaminated by ‘lead debris’, was collected and analysed for these two elements. The study main conclusions are: (i) Atmospheric emissions still play an important role in Pb and Cd superficial soil content; (ii) the influence of the ‘lead debris’ on Pb contamination of the soil in the urban area of the town of Santo Amaro was clear. The first conclusion is obvious and this has already been found in several other areas surrounding lead smelters.[2–7] The second conclusion is driven by misunderstandings in the findings in the literature and the experimental data regarding Pb and Cd soil content.

The authors misused the term ‘lead debris’ to describe the lead smelter solid waste that was landfilled close to the smelter and was also used as a construction material in the town. In fact, it is a specific material, the primary lead smelter slag that was carefully characterized and shows short-term stability. [8–11] The authors’ slag stability study, however, shows ambiguous results for Cd and Pb leaching by acetic acid and water, which indicate quality control issues.[12]

The authors presented simulation results for air dispersion using the software AERMOD View v.5.8 (by Lake Environmental), which is based on the Gaussian model and is useful to assess pollution concentration and deposition up to a range of 50 km.[13] However, the authors used meteorological data, including wind speed and direction from the Salvador airport station, which is about 80 km from the Santo Amaro smelter. It must be said that the coastal wind field is drastically changed due to the Todos os Santos Bay and the Subaê River valley and this was not taken into account. In this study, no data regarding the dispersion coefficient values or dispersion classes are provided.[13] Furthermore, the characterization of the emitted particulate material, whose dispersion was also simulated in this study, is not presented. Finally, the assumption that the SO₂ emissions were released from the main chimney and particulate material emissions were released from the seven smaller chimneys distributed throughout each stage of the process is completely unrealistic, because most of the refined lead at the Santo Amaro smelter was produced after the construction of the 90 m chimney that received gases and particulate material, not collected by the filters, from both sections of the plant, the roasting and the refinery.[7,14] Therefore, the dispersion simulation results presented in the study to describe heavy metal contamination at the Santo Amaro smelter region are questionable.

In this study, the experimental data of the Pb and Cd soil content special distribution are fitted using an unphysical empirical equation, which does not exhibit the expected concentration peak close to the source.[13] The fit constants for the Pb and Cd soil content in the two cases (soil close to slag and soil without contact with the slag) was then used to support the authors’ claim that the slag has a significant effect on soil contamination by heavy metals.

Primary lead slag is a brittle material due to the amorphous structure created by the quenching process.[9,15] It has a larger amount of Pb, Zn, Co and Ni and significant amounts of As, Cu, Ag and Cd, but these elements are relatively stable in this slag. Due to the fact that a larger amount of small size particles will be generated by the accidental slag particles breakage in transportation and in use as construction and pavement material, the separation of soil and slag by hand-picking is almost impossible. Therefore, the high content of heavy metals in the soil samples collected close to the slag particles seems to be an artefact due to the small fragments of slag that are described as soil particles.

The measured Pb and Cd soil content should be presented separately for each axis around the smelter chimney, including the average values and errors bars for each data sample. This would provide information to assess the samples representativeness, the contamination by slag and the quality of the analytical methods. The use of the quoted data of soil Pb and Cd content in this context is also questionable.

Soil characterization using flame atomic absorption spectroscopy and the analysis of only two elements (Pb and Cd) with high detection limits, respectively 10 and 1.0 mg/L, is insufficient to correlate the results of soil

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contamination with emission effects or slag alteration. Nowadays, the use of ICP-MS, INAA or other modern analytical methods is mandatory in most environmental studies related to heavy metals to assess several trace elements at low concentration.

The correlation between the Pb and Cd soil content with the simulated atmospheric dispersion results is misleading, especially due to the weaknesses related to simulation conditions and soil sampling and analysis, mentioned above.

Figure 3 in the paper [1] shows the distance–ground level concentration decline behaviour. The variability of the data, however, is too strong. The data for the ‘urban zone’ do not follow the distance decline behaviour. In contrast, the results presented in Figure 4 in the paper [1] for the Cd content in the soil samples collected in the ‘urban zone’ have the distance–ground level concentration decline behaviour without any anomaly. Due to the fact that the slag has a low Cd content (57.3 mg/kg) and high Pb content (37,000 mg/kg), these results clearly show the artefact generated by the slag fragments on the soil samples’ heavy metal content. Therefore, the results summarized in Figures 3 and 4 in the paper [1] do not constitute evidence of other active pathways for Pb contamination other than the well-known airborne emissions. Rather, they present a confirmation that the soil samples are contaminated by the lead slag.

The use of the dispersion simulation results based on meteorological data for an inadequate station, the use of uncharacterized emitted particulate material and dispersion coefficients values or dispersion classes and the use of an unreal chimney geometry and configuration casts considerable doubt on the results and discussion. Therefore, the correlation of these data with the measured soil Pb and Cd content has no meaning.

In conclusion, the paper by Machado et al. [1] presents doubtful experimental results for soil Pb and Cd contamination and atmospheric dispersion and uses a doubtful method for fitting the data with an unphysical model. Therefore, it provides no evidence and cannot support the predicted effect of slag alteration on the soil contamination in the Santo Amaro smelter region. The authors should, therefore, reconsider the conclusions of their study, taking into account findings in the literature.

Supplementary information
Supplementary content may be viewed online at http://dx.doi.org/10.1080/09593330.2013.788071.

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