



Evaluation of the interaction of As, B and Pb from geothermal fluids with agricultural soils

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Although geothermal energy has shown to be a low pollution energy source; air, soils and water next to geothermal plants may be affected by their operation. One of the largest geothermal energy source of the world, “Cerro Prieto” with a capacity of 720 MW, is located northwest Mexico within an agricultural area. The abstracted geothermal fluids enriched in As, B, Pb, Cd, and other heavy metals, are either reinjected to the aquifer or send to an evaporation pond located in the geothermal plant. However, since spills have occurred at other geothermal zones, it is important to evaluate the effect of those contaminants on soils of the surrounding area and their possible infiltration to shallow groundwaters. To that aim, soils (one chromic vertisol and two calcic regosols) from three sites close to the Cerro Prieto plant were sampled to evaluate their behavior regarding As, Pb and B retention. Batch experiments were carried out using the soils as the sorbent and geothermal water from three geothermal wells as the sorbate. Raw water concentrations were: As 0.2442 mg/L, 0.2774 mg/L and 0.738 mg/L, B 18.409 mg/L, 13.5075 mg/L and 16.646 mg/L, Pb 0.27mg/L, 0.16mg/L and 0.3 mg/L. Physico-chemical characteristics of the soils were determined and related to the experimental results. A good adjustment of the chromic vertisol sample to Freundlich isotherms was observed for As ($r^2 > 0.9$), followed by Pb ($r^2 = 0.61$), and B ($r^2 > 0.5$); besides, As retention also showed a good adjustment to the Langmuir model ($r^2 > 0.9$). The retention followed the order $Pb > As > B$ in one of the two calcic regosols, while the other only retained $Pb \gg As$. Cationic exchange capacity, and clay minerals, carbonate, organic matter, Fe, Al and Mn amorphous and crystalline oxides contents influenced the soils retention capacity. Irrigation with the geothermal water would not imply a toxicity risk to plants raised in the chromic regosol due to its high Pb and As sorption capacity. Lead concentration would not be a toxicity problem in one of the calcic regosols for the same reason but As and boron would be more available. Boron would be a hazard to vegetables and water due to its low or lack of retention in the three soils, and also for its possible infiltration to shallow groundwater that is used for irrigation in the area. This study highlights the importance of maintaining a good and controlled operation of the geothermal plant.