Investigation about Cd (II) Immobility in Contaminated Soils Using Phosphate Fertilizer, Heat, and Lime ($CaCO_3$)

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Introduction: Cadmium is one of the most important environmental pollutants that can be resulted from different ways. It can easily contaminate soil and water resources. Since phosphate ions for stable complexes are available with cations such as Pb and Cd, so it can cause a decrease in the solubility and mobility of heavy metals in soil. Liming is the most widely used treatment that leads to precipitation of the metals as metal–carbonates and significantly decreases the exchangeable fraction of metals in contaminated soils. Temperature is also an important factor in stabilization of heavy metals. Heat causes loss of water and hydration around cations to move them to empty spaces in clay part of soil. The aim of this study was to investigate the effect of heat and lime, and phosphate application on immobilization of Cd in contaminated soil with incubated days.
Materials and methods: Samples of soil were collected from waste mining of Angorane in Zanjan area. After air-dried and homogenized, they were sieved at about <2mm. For stabilization, two levels of lime 0, 5% and 0, 2.5% phosphate fertilizer and mixed of lime (0, 5%), phosphate fertilizer (0, 2.5%) were selected and mixed with 300 gr of soil. Treatments as six different temperatures 25, 200, 400, 600, 700 and 800°C were heated with electrical oven (Shimiran f.47) and loaded in distilled water for different times (7, 30, 60days). At this time, every day the samples were shaken in 15 minutes. Samples were centrifuged for 5 minutes at 2500 rpm and passed through a filter paper and the filtrate concentration of the supernatant was harvested. Cadmium concentration was measured in the supernatant using atomic absorption model (Shimadzu 6600). All analysis of variance and mean comparison were performed using SPSS and MSTATC applications.
Discussion of result: Table 1 showed characteristics of soil samples in the tested soil. The soil was acidic and saline due to the existence of salts of Cd and Pb. The high amount of salts increases the Ionic strength of soil and affects the absorbing processes. It is poor in lime 0% (total $CaCO_3$), so the salts may be sulphate of Cd and Pb. The soil fraction less than <2mm is characterized as silt loam. The result of XRD showed Kaolinate, Ilite and smectite. Total Cd concentration was 225mgkg-1 that showed more contaminated soil. Based on the America's environmental protection agency (EPA) standards the allowable limit for the existence of Cd in soil is 3 (mgkg-1). Thus, concentration of the metal in the soil was standard and introduced as a contaminated soil.
Influence of phosphate fertilizer and lime The results indicated that application of lime can decrease Cd sorbtion in soil with high salinity. Lime content decreased constantly as the temperature inclined. Loss of carbonates as CO form is the reason that causes the release Cd in heated soil. But phosphate fertilizer application causes the decrease of release Cd in soil sample at 200°c (Fig. 1). The researchers showed that by increasing phosphate, phosphate ions lead to precipitation of Cd-phosphate. The combined effects of phosphate and lime synergistic mode (Synergism) cause increase in soil pH. Under these conditions an increase in temperature had a lower effect on destruction of structure in clay minerals and stabilization process.
Conclusion: Ione phosphate leads to stabilization of Cd. The increase of temperature causes the change direction effect of phosphate at stabilized cadmium and increased solubility and transport in the soil. Therefore, cadmium gets more stabilized by passing time. Furthermore, use of lime for cadmium stabilization in saline soil appeared to be ineffective but use of phosphate source was effective.

Keywords: Cd, contaminated soil, heat, lime, phosphate, stabilization