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Evaluation of Soils Pollution to Chromium, Nickel and Cobalt as Affected by Ophiolitic Formations in Neyriz Region, Fars Province

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Introduction: The heavy metal concentration in agricultural lands, due to the toxicity, persistence and their accumulation in the environment has become a major concern. Ophiolitic formations extend in southern part of central Iran and parallel to folds of the Zagros Mountains, is located in the north of Neyriz town and in the west of Bakhtegan Lake. Rock weathering of these complexes forms sediments and soils with a large amount of Mn, Ni, Cr, Co, Mg and Fe. Laboratory analysis of Neyriz ophiolitic rocks indicates that they are a source of heavy metals as well, and may cause problems for the environment. However, there is no investigation in Neyriz area regarding contamination of the soils. The present study was conducted to assess soils pollution in Ghal-e Bahman area, 20 km from Neyriz which derived from ophiolitic formations of this area.

Materials and Methods: The study area located in the Ghal-e Bahman region, eastern part of Bakhtegan Lake. The soils of this region are affected from Neyriz ophiolite. In this region, three physiographic units including a hill, an alluvial fan and a lowland (playa) were separated. In each unit, some pedons were dug and classified according to American Soil Taxonomy. Soil samples were obtained from each genetic horizon and rock samples were also taken from ophiolitic formation. Then, chemical and physical properties were determined. Heavy metals were also extracted by nitric acid and amount of Cr, Ni, Co and Fe were calculated. Enrichment Factor (EF) and Geo-accumulation indices (I_{geo}) were also calculated and soils were classified according to their pollution level.

Results and Discussion: In general, soils on different landforms had different horizon properties and different classification. They are varied from a shallow, thin layer on hills to relative deep layer on lowland. These soils were classified in three different subgroups according to American Soil Taxonomy. Soils on ophiolitic hills classified as Lithic Torriothents because of a thin surface layer on a weathered bedrock. Soils developed on alluvial fan landform, with several alluvial subsurface horizons with different rock fragments percentage and size, was classified as Typic Torrifluvents; and the soils on lowland (Bakhtegan playa) was Gypsic Aquisalids because of salt and gypsum concentration in all layers and had redox color (chroma of less than 2) affected by high level of groundwater in the soil surface and subsurface layers.

The results showed that the amount of chromium with the average of 2200 $mgkg^{-1}$, was 10 to 40 times higher than the Iran and Europe threshold levels (100 and 150 $mgkg^{-1}$, respectively). The amount of nickel, with the average of 300 $mgkg^{-1}$,were 10 fold higher than the threshold level and cobalt (19 $mgkg^{-1}$) was lower than criteria defined by soils standards of Iran and Europe (40 $mgkg^{-1}$).The amount of studied metals were the highest in ophiolitic hills, and playa soils were in second place in this respect. The amount of metals had a significant decrease in alluvial fan but didn't drop under threshold level. The lowest amount of heavy metals in alluvial fan was probably because of the high percentage of sand, higher permeability and low soil water retention in all horizons. The negative significant correlation between the elements and sand also confirms this hypothesis. In addition, increasing elements at the depth of 70 cm of the soil in alluvial fan showed that land type (orchards) and long period of irrigation may cause leaching heavy metals from topsoil to the soil depth. However, no significance correlation was observed between the elements and soil organic carbon. The correlation coefficients between three elements revealed that all of them had the similar geologic origin and thus their spatial occurrence in soils can be attributed to the weathering of similar parent material.

I_{geo} showed an almost constant trend from ophiolitic hill (7.7-7.8) to alluvial fan (7.2-7.7) and a significant decrease in playa (3.9-6.2) for all metals. The variation of EF for nickel had an almost constant trend from ophiolitic hill (with the average of 0.6) to alluvial fan (with the average of 0.7) and a significant decrease in playa (with the average of 0.1). Also, a decreasing trend was observed from ophiolite hill (0.9 and 0.6 for chromium and cobalt, respectively) to alluvial fan (0.5 for both) and playa (0.3 and 0.1 for chromium and cobalt,

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respectively). A decreasing trend observed for indices can be due to the reduction of sediment transport processes and dilution effect of elements from hill to playa during the deposition and their formation .It seems that the EF index and the I_{geo} provide more useful information about hydrologic processes during formation of landform and development of soils than absolute values of heavy metals.

Conclusions: The present study showed that the amounts of chromium and nickel were higher than the threshold in studied soil. The soils derived from ophiolitic formation showed the highest values and the soils over alluvial fans had the lowest levels of heavy metals. Useful information was obtained from EF index and I_{geo} about the prominent geomorphic processes during landforms formation

Future studies should be focused on possible transfer of these elements into the groundwater and also trees of the orchards in Ghal-e Bahman region.

Keywords: Enrichment Factor (EF), Geo-accumulation index (I_{geo}), Heavy metals, Neyriz ophiolitic formations, Pollution