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Geochemistry of soils derived from selected sedimentary parent rocks in Kopet Dagh, North East Iran

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Abstract

Geochemical composition of soils from arid regions is greatly affected by parent materials. In order to investigate the effects of parent materials and pedogenic processes on elemental distribution in some selected soils formed on sedimentary parent rocks in Kopet Dagh area, six representative pedons were characterized by geochemical, micromorphological and clay mineralogical studies. Multivariate statistical analyses were used to interpret geochemical data. In this regard, principal component analysis (PCA) was employed to investigate relationships among elements and cluster analysis was also performed to group soil samples on the basis of geochemical affinity. Calcitic features, gypsum accumulations and pedoturbation were found the most common pedogenic features in the studied soils.

The different concentration of elements in soils and parent materials were ascribed to different abundances of major mineral constituents i.e. calcite, gypsum, quartz and montmorillonite. Weathering characterization of soils by geochemical indexes showed that variations of Ba/Sr, Rb/Sr, Ca/Zr and ICV (index of compositional variability) within soil profiles are affected mainly by dissolution and redistribution of calcite and/or gypsum.

Based on PCA of Ln-transformed data for elements and selected soil properties, four main types of inter-element relationships could be recognized. These types of relationships which are attributed with host minerals of elements are: the trace elements that tend to be adsorbed on clays or substituted for Al, Fe and K in clay minerals or iron oxides (type 1), highly immobile elements comprising rare earth elements (REEs), Ta, Nb and Th (type 2), elements that can incorporate in silicate minerals lattice including Mg, Na, Zr and Hf (type 3) and finally type 4 with Ca and Sr that reside in calcite and gypsum.

The variation of mineralogical composition and as a consequence elemental distributions within soil profiles are influenced by parent materials and pedogenic processes. The abundance and distribution of elements which are in association with each other in types 1, 2 and 3 were mainly controlled by parent materials. In contrast, Ca and Sr were not only affected by parent materials but also by dynamics of calcite and gypsum in soil profiles showing calcification and/or gypsification.

By applying cluster analysis on the basis of major and trace elements geochemistry, the soil types are well discriminated and their clustering is influenced by contents of CaCO₃, gypsum, clay and Fe₂O₃.

In general, these results support the important influence of parent material on soil geochemistry in arid areas. Additionally, calcification and gypsification, as prevailing pedogenic processes in these areas, can effectively affect elemental distribution within soils.

Key words: soil geochemistry, parent materials, arid environments, Kopet Dagh, Iran.

1. Introduction

The effect of parent materials on soil properties has long been recognized. Parent material is one of the five factors affecting soil formation (Jenny, 1941). In fact, parent material is the framework for soil profile development (Schaetzl and Anderson, 2005). Specifically in arid and semi-arid condition, parent materials have important effects on pedogenic processes and soil evolution pathways (Badía et al., 2013;

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