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Study of Magnetic Susceptibility of the Soils of a Toposequence Case Study: Beshar Plain, Kohgilouye Province

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Introduction: Magnetic susceptibility measurements can serve a variety of applications including the determination of changes in soil-forming processes, the study of parent material effects, understanding sedimentation processes, soil drainage conditions, and even the separation and identification of soil delineations. The technique is especially attractive since it is relatively rapid, non-destructive, and can be applied to both intact and disturbed samples of soils. Magnetic susceptibility is defined as the ratio of the total magnetization induced in a sample relative to the intensity of the magnetic field that produces the magnetization. Iron oxides are the most abundant of the metallic oxides in most soils; they are present in all climatic regions, in several mineral forms, and at variable concentrations. Typically, selective dissolution techniques are used to quantify the relative proportion of Fe oxides. Due to the large contribution of iron-bearing minerals to magnetic susceptibility, their presence in most soils, and the effects of the biophysical environment on them, pedologists have been paying growing attention to magnetic susceptibility as a means to understand soil and landscape processes. The effects of topography on χ were studied for example by many workers. They found that soil susceptibility changes with the position of a soil profile on a slope. Texture and drainage class assumed to be the main reasons. The soils of the Beshar Plain formed on the relatively same parent materials and are mainly affected by topography and land use. The objective of this study was to examine the role of topography and land use on pedogenic processes and their relation to soil χ, as well as, profile distribution of secondary Fe oxides, and the χ profiles.

Materials and Methods: This study was conducted on the Beshar Plain, Kohgilouye Province, in southwest of Iran. Physiographically this plain comprises hill, piedmont plain, river traces, and plateau. Eleven representative pedons were dug along a transect crossing the main physiographical units. Five pedons demonstrated aquic soil moisture regime. The mean annual temperature and precipitation at the site was 14.7°C and 800 mm, respectively. Soil moisture and temperature regimes of the study area were xeric and thermic, respectively. The soils were classified according to soil taxonomy and WRB. The soil pH was measured in a saturation paste and electrical conductivity (EC) in a saturation extract. Cation exchange capacity (CEC) was determined using sodium acetate (NaOAc) at a pH of 8.2. Soil texture was determined using the pipette method. Calcium carbonate equivalent (CCE) was measured by acid neutralization. Organic carbon was determined by wet oxidation method. Pedogenic Fe (Fe_o) and pseudo-total Fe (Fe_n) were extracted with the CBD method and HNO_3, respectively.The magnetic susceptibility of bulk samples was determined using a Bartington MS2 meter equipped with the MS2B Dual Frequency sensor, capable of taking measurements at both low (χ_{lf} at 0.46 kHz) and high (χ_{hf} at 4.6 kHz) frequencies.

Results and Discussion: The soils were classified as taxonomic orders of Entisols, Mollisols, Inceptisols and Alfisols, according to the world reference base for soil resources (WRB) as reference soil groups of Kastanozems, Regosols, Gleysols, Luvisols, Fluvisols and cambisols. The dominant pedogenic processes in the soils were the accumulation of organic matter, the leaching of carbonates, and formation of calcic horizons, the mobilization of clay and development of argillic horizons. The results indicated that the soils are affected mainly by topography, drainage class and land use. Most pedons exhibited maximum of χ at the soil surface, suggesting preferential loss of diamagnetic components, as well as more pedogenic formation of antiferromagnetic minerals. Magnetic measurements showed that the χ values of aquic soils were much lower than those of non-aquic soils (43%). The highest value of χ was noted in pedons which are located on stable physiographic units and the lowest belong to those which are located on river lower terraces. Fe_d and fe_n was also positively correlated with χ in the soils studied. Aquic condition also decreased Fe_d and Fe_d/Fe_n, 44 and 65 percent, respectively with no clear effect on Fe_n. Low to medium amounts of χ_{fd} in the studied soils indicated that superparamagnetic gains are not too dominant in the soils. Higher values of χ_{fd} were typically observed in the A horizons than at depth,

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suggesting a greater proportion of ultrafine grains at soil surface. A positive correlation existed between χ_{fd} and χ in the soils.

Keywords: Aquic condition, Fe oxide, Land use, Soil evolution