Effect of long-term fertilization on the composition and evolution of clay minerals in soil particles

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Abstract: On the basis of the long term positioning experiment in the Wuxue City of Hubei Province, the mineral assemblages and chemical compositions of clay minerals in various particle fractions (<2000, 450~2000, 100~450 and 25~100 nm) of different fertilizer treated (by nitrogen, phosphate, and potassium fertilizers (NPK), or by nitrogen, phosphate, and potassium fertilizers coupled with straw ash (NPKS)) soils and uncultivated soils (HD) from the long term positioning experiment field have been sampled and investigated in this paper to reveal the variation characteristics of clay minerals in farmland soil particles under various treatments of fertilization. The results indicate that the different fertilizer treated soils have generally similar compositions of clay minerals, with major kaolinite and minor vermiculite, HIV (1.4 nm sized intergradient mineral), and illite. With the decrease of the particle size in soils, clay minerals in the soils are gradually transited from the 1:1 to 2:1 types. Comparing with uncultivated soil, the NPK treated soil contains lower contents of illite and vermiculite but higher contents of HIV, while the NPKS treated soil contains lower content of illite but higher contents of vermiculite and HIV. With the decrease of soil particle size, the SiO_2 and Fe_2O_3 contents of 3 kinds of soils are gradually are decreased, but the content of Al_2O_3 is increased. Especially, with the decrease of particle size, the SiO_2/Al_2O_3 and $SiO_2/(Al_2O_3+Fe_2O_3)$ ratios are decreased gradually in three kinds of soil particles. Comparing with the uncultivated soil, the NPK and NPKS treated various sized soil particles have no significant changes in the elemental composition, but have significantly higher SiO_2/Al_2O_3 and $SiO_2/(Al_2O_3+Fe_2O_3)$ ratios. The free iron and aluminum contents of three kinds of soil particles are subsequently decreased from the HD, then the NPKS, to the NPK. This is consistent with the change of iron freeness. There is no obvious relationship between the amorphous iron, aluminum contents and the variation in iron activation. With the decrease of soil particle size, the contents of iron and aluminum oxides in various forms are gradually increased. This is in agreement with the variation of degrees of iron freeness and activation.

Keywords: long-term fertilization; soil particles; clay minerals; oxide composition.