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Genesis and Usefulness of 0.7 nm Minerals (Kaolinite and Kaolin) in Indian Tropical Soils: Exploring Realm

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Abstract: *After the adoption of the US Soil Taxonomy in 1969 to classify the soils of the country, Indian soil and clay scientists initiated the research on the genesis and transformation of clay and other minerals of major soil types of the country with an emphasis on the genesis of 0.7 nm minerals (kaolin and kaolinite) of red ferruginous (RF) soils of the peninsular regions. Although the RF soils of humid tropical (HT) and semi-arid tropical (SAT) climates are dominated by the clay minerals of advanced weathering stage like 0.7 nm minerals, they are useful substrates in supporting various land use plans in almost 33% of total geographic area of the country. This suggests that 0.7 nm minerals have positive influence in some important soil properties, which distinctly support in producing sufficient food grains for a large Indian population. However, the inherent link between 0.7 nm minerals and some bulk soil properties waited for a long time to be established. A critical appraisal of the nature and properties of 0.7 nm minerals highlights the genesis of kaolin and kaolinite in acidic Inceptisols, Alfisols, Mollisols, Vertisols and Ultisols of humid tropical (HT) climate in the north-eastern hill (NEH) regions, Western Ghats, southern and some eastern states would be way forward for further investigation. The dominant 0.7 nm mineral in soils of HT climates is a randomly interstratified clay mineral of 0.7nm and hydroxy-interlayered smectite (HIS)/vermiculite (HIV) (kaolin), which formed pedogenetically in the prevailing HT climate and thus, it is not a pure kaolinite. On the other hand, geomorphic and paleoclimatic history of the kaolinite dominated Alfisols developed on the Pre-Cambrian gneissic rock system indicates its formation as well crystallized kaolinite through the diagenetic or metamorphic alteration of plagioclase feldspar and biotite mica during the HT climate of the past geological period, and remain as a remnant clay mineral in soils of SAT climate. I attempted to elucidate how the presence of interstratified component like HIS, and HIV in kaolin, and the interleaved micaceous layers of biotite in kaolinite crystals with high surface due to isomorphous substitution of Fe in their octahedral layers help in: (i) better sequestration of organic carbon than crystalline layer silicates, (ii) understanding the subtle release and adsorption reactions of N, P and K, and (iii) realizing how Al-toxicity is arrested by hydroxy interlayering of Al^{3+} ions in smectite and vermiculite interlayers in highly acidic soils. The evidence provided here highlights the fact the kaolin or kaolinite dominated RF soils of India are endowed with a soil substrate that in practice acts as an efficient eco-system provider in producing sufficient food stocks for a sizable Indian population.*

Keywords: Acid soils; hydroxy-interplayed smectite and vermiculite; Al-toxicity; kaolin; kaolinite; sequestration of organic carbon; release and adsorption of N, P and K; Soil clay minerals of India