Timtong Darunsontaya 2011: The Mineralogy of Upland Agricultural Soils Under Tropical Monsoonal Environment in Thailand. Doctor of Philosophy (Soil Science), Major Field: Soil Science, Department of Soil Science. Thesis Advisor: Associate Professor Anchalee Suddhiprakarn, Ph.D. 183 pages.

Twenty one soils profiles on various parent materials under a tropical monsoonal climate in Thailand were analyzed for chemical and mineralogical properties of the clay-sized minerals. These Oxisols and Ultisols have kaolinite as the dominant clay mineral and various amounts of accessory minerals with higher amounts of sesquioxide minerals in Oxisols. The crystal size of kaolinite and iron oxides is smaller for basaltic soils relative to soils on granite and sedimentary rocks. Halloysite tubes occur in some soil clays particularly for basaltic soils and these soils also contain gibbsite. Oxisols derived from basalt have relatively higher contents of Fe, Ti, Mg, Mn, Ba, Be, Bi, Ce, Co, Cr, Cu, Ga, La, Nd, Ni, Sc, Sr and Zn. Statistical analysis indicates a lithosequence where soil parent material is the main factor influencing the mineralogical and chemical properties of the clay fraction of these soils.

Clay samples from surface and subsurface horizons of these upland soils were characterized for chemical composition, mineralogy and K release to 0.3M sodium tetraphenylboron (NaTPB) solution for periods up to 168 hours. Analytical TEM and XRD show that most clays contain small amounts of illite. Potassium release kinetics for all samples are adequately described by the parabolic diffusion (r=0.91-0.99), power function (r=0.87-0.99) and Elovich equations (r=0.86-0.99). The intercept constants of the equations are strongly positively related to the ratio of illite to kaolinite and total K and Mg contents of the clays. These relationships indicate that minor amounts of illite in these clays strongly affect the kinetics of K release. The slope constants of the parabolic and Elovich equations are also positively related to these clay properties. Some kaolinite particles contain K which may be present in residual micaceous layers interleaved in kaolinite crystals. XRD patterns from samples extracted with NaTPB show a decrease in illite peak intensity with a concomitant increase in vermiculite peak intensity due to K removal from illite by NaTPB.

Critical assessment of the forms of K in soils and of the ability of soils to release K for plant uptake was also studied. The relationships between different pools of K were investigated as a function of silt and clay mineralogy. Most soils contain no K-minerals in the silt fraction. For some soils, both conventional and synchrotron XRD were unable to detect illite. Analytical TEM including EFTEM of individual clay crystals show that clay in the apparently illite-free samples contain very small amounts of illite. A glasshouse K-depletion experiment was conducted to assess the K supply capacity and changes in chemical forms of K and K- bearing minerals using exhaustive K depletion by Guinea grass (*Panicum maximum*). Potassium deficiency symptoms and mortality of plants occurred on light textured soils, whereas plants survived for six harvests for Oxisols with clay texture, relatively high CEC and higher exchangeable K. There is a strong linear relationship of unit slope between exchangeable soil K and cumulative K uptake by plants indicating that exchangeable K is a major form of K available to plants. Thus K-bearing minerals contributed little K to plants over the time scale of the experiment and XRD patterns of whole soil samples, silt and clay from soils after cropping mostly showed no change from those for the initial soil. An exception was for a single surface soil clay where a minor amount of smectite was formed from illite by K release to plants.

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