
Clay Mineral Stability as Related to Activities of Aluminium, Silicon, and Magnesium in Matrix Solution of Montmorillonite-Containing Soils

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Abstract: The influence of geomorphological site characteristics on soil clay mineral stability of montmorillonite-containing horizons of a southern Wisconsin soil catena was interpreted in terms of the solute activity function values of $p\text{Si}(\text{OH})_4$, $\text{pH}-1/2p\text{Mg}^{2+}$ and $\text{pH}-1/3p\text{Al}^{3+}$ in suspensions of the separated clay fractions. Montmorillonite stability and/or formation vs that of kaolinite for the soil clays was evaluated by a plot of the solute activity functions on a three dimensional diagram derived for montmorillonite, kaolinite, and gibbsite at constant temperature (25° C) and constant pressure (one atm.). Although all the soil clays contained both montmorillonite and kaolinite, the position of the soil clay solute activity functions in the stability diagram clearly reflected the influence of the geomorphological—geochemical site conditions in which each soil horizon was developed, with corresponding differences in the $\text{SiO}_2/\text{Al}_2\text{O}_3$ molar ratio of the reactive fraction. Montmorillonite stability positions of the solute activity functions were induced by soils (clays with reactive fractions with $\text{SiO}_2/\text{Al}_2\text{O}_3$ molar ratios = 3– 4) from calcareous or poorly drained horizons, while kaolinite stability positions of the functions were induced by soils (clays with reactive fractions of $\text{SiO}_2/\text{Al}_2\text{O}_3$ molar ratios = 2) from acid, freely drained horizons.

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