
Quantitative Clay Mineral Analysis Using Simultaneous Linear Equations¹

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Abstract: A program of simultaneous linear equations has been developed to calculate component proportions and/or component property values for mineral mixtures in soil clays and sediments. The analysis is based on quantitatively measured chemical and physical properties of samples and involves (1) qualitative identification of the mineral components in the mixture by any appropriate means; (2) quantitative measure of the sample property values selected for use in the program; (3) estimation of the proportion of each component in the mixture by a technique such as X-ray powder diffraction; (4) assignment of limits to component property ranges; (5) selection of one of four available calculation options and application of the simultaneous linear-equations program; (6) examination of the residuals of the analysis and, if appropriate, adjustment of the initial estimates for component proportions or property ranges and then repeating step 5; and (7) verification of the final component proportions by comparison with information from step 1. Completeness and/or accuracy of the final results for component proportions may be checked by the closeness of approach to 1.0 for the sum of the component proportions. The method requires that, at minimum, the number of properties measured must equal the number of components in the samples being analyzed and that the minimum number of samples must equal the number of properties measured.

Using the clay fractions of 15 Pennsylvania soils containing kaolinite, illite, smectite, vermiculite, chlorite, interstratified vermiculite/chlorite, quartz, and noncrystalline material, and measuring methylene blue cation-exchange capacity, the amount of Ca displaced by Mg from a Ca-saturated clay, the amount of K displaced by NH₄ from a K-saturated clay heated to 110° C, % K₂O, % SiO₂, % MgO, and weight loss at 110° – 300° C and 300° – 950° C, the adjustment of property values was found to have the lowest residual value and the most consistent results. The source of analytical errors was also located by examination of residual tables. Samples that were similar in composition gave more reliable component proportions.

Key Words: Cation-exchange capacity • Chemical analysis • Linear equations • Mineral analysis • Quantitative mineralogy • Weight loss

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