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New method for determination of smectite proportion in sediments and soils of potential landslide sites using thermogravimetric analyses

F. Nieto (1), I. Abad (2), **J. M. Azañón** (3)

(1) Dpt. Mineralogía y Petrología and IACT, Universidad de Granada-CSIC, Spain, (2) Dpt. Geología, Universidad de Jaén, Spain, (3) Dpt. Geodinámica and IACT, Universidad de Granada, Spain.

Information on smectite proportions in potential landslide sites can be vital to the success of engineering projects. In areas with a typical Mediterranean rainfall regime, expansive soils are responsible for numerous slope instabilities that affect roads (Yilmaz and Karacan, 2002). In slope stability studies, engineers need to know the smectite contents in order to predict how the material will perform; one of the properties used in engineering soil classification is the type and amount of clay. X-ray diffraction (XRD) methods have frequently been used for quantitative analyses, but factors related to the quantitative analyses of minerals such as orientation, crystallinity, homogeneity of the sample, effect of solid solution series, and calibration of the diffractometer are difficult to control. Eight samples have been prepared as mixtures in different known proportions of hydrothermal quartz, pegmatitic mica, calcite, and smectite to check traditional quantitative XRD methods. The Internal-Standard method has been applied in addition to the Chung method, the most common one for the majority of published results in geological literature. The results by both methods present a certain amount of error that is particularly evident for four samples, for which the smectite quantities obtained by the Internal Standard method are patently absurd. Since the quantitative determination of minerals has always been a complex matter, we have explored the possibilities of thermogravimetric analyses, taking into account the facility of smectites to adsorb organic substances.

Smectite is quantified by thermogravimetry with a new method consisting in measuring the weight loss between 100 and 450 ºC of samples solvated with ethylene glycol

and previously saturated in Mg. The proportion of expandable material in the sample is calculated according to the following equation, obtained from the artificial mixtures prepared with variable proportions of smectite: $y= 3.96x-4.05$ ($R^2=0.96$), where x is the percentage of loss and y is the percentage of smectite in the sample. The slope of the equation agrees perfectly with the theoretical proportion of ethylene glycol in a solvated smectite, around 25%, and with the equivalent values determined on five natural standards of various smectite compositions. In addition, the ordinate of the origin is also in agreement with the values of around 1% obtained in smectite-free samples. The method proposed is low-cost and easy to apply as a complement to X-ray diffraction determinations of expandable clay content in sediments and soils with the potential for landslides in civil engineering.

Reference

Yilmaz I, Karacan E (2002) Environmental Geosciences 9, 35-42.