SCIENCE DU SOL n° 1986/1 - pp. 141-142 - PLAISIR-FRANCE

THE DETERMINATION OF AMORPHOUS AND CRYPTO-CRYSTALLINE MINERALS OF ANDOSOLS BY A KINETIC ANALYSIS OF THEIR DISSOLUTION BY HCl AND NaOH

P. QUANTIN [1], **A. BOULEAU** [1]

(Science du Sol n° 1983/3-4)

The aim of this study is the qualitative and quantitative determination of the secondary minerals of andosols, in an amorphous or crypto-crystalline state.

The Segalen's method, the differential kinetics of dissolution by alternated HCl and NaOH reagents, as been used. But, the conditions of use for each reagent have been diversified (table II) in order to reveal some more selective steps of dissolution than by initial method. Twelve types of soils and minerals (table I) have been tested, among these two very different types of andosol :

— an unsaturated and perhydrated andosol (hydrandept) containing imogolite and gibbsite — a saturated andosol (eutrandept), rich in hisingerite and opal. In addition, three horizons of a rejuvenated-perhydrated andosol have been compared.

A - On the perhydrated andosol, rich in imogolite, four expriments have been noteworthy.

a) The dissolution by alternated 4 N HCl and 0.5 N — 50°C NaOH (fig. 1), is very strong and fast for about 90 % of Al and Fe and 40 % of Si. But the X ray diffraction shows that gibbsite and some halloysite are dissolved (fig. 2), in the same way as amorphous products.

b) The separate dissolution by 4 N HCl or 0.5 N — 50°C NaOH (fig. 1), shows that only NaOH dissolves gibbsite and fine halloysite. Moreover, this effect is emphasized by interaction of the two reagents.

c) In the case of alternated reagents, the decrease of soda temperature (to 25°C) or concentration (to 0.1 N), can significantly reduce the solubility of gibbsite and halloysite (fig. 3 and 4).

d) The variation in the concentration of HCl shows two significant steps of the dissolution rate for magnetite (8 N to 4 N) and for fine goethite (4 N to 2 N).

By inference the results have allowed to determine the approximate amount of the amorphous (Al, Fe hydroxides), para-crystalline (imogolite) and very soluble minerals (gibbsite, goethite, halloysite).

B - On the saturated andosol, rich in hisingerite and opal, four experiments have been noteworthy.

a) The treatment by aternated 8 N or 4 N HCl and 0.5 N — 100°C NaOH gives three phases of dissoluted products (fig. 7 and 8) which can be interpreted as allophane-like, iron-rich alumino-silicate (fig. 9) and free (amorphous and para-crystalline) silica. In addition, the lesser the HCl concentration the greater the silica dissolution (fig. 7).

b) The separate dissolution (fig. 10), a smuch by 4 N HCl as by 0.5 N — 50°C NaOH, is not effective enough to dissolve either all the free silica or the iron-rich allophane. On the contrary, there is a strong synergetic effect of the two reagents, when they are used alternatively or successively.

c) In the case of alternated reagents, the decrease of soda temperature is

(1) S.C.C. ORSTOM, 70, route d'Aulnay, 93140 Bondy.

ineffective, while the decrease of soda concentration (to 0.05 N, fig. 11 and 12) only reduces a little the solubility of the free silica (probably in the amorphous state).

d) The decrease of HCl concentration (from 4 N to 2 N) is ineffective.

Finally, the inferable interpretation of a dissolution diagram (fig. 13) has allowed to determine the approximate amount of hisingerite, fine amorphous silica and opal.

C - On three horizons of the rejuvenated perhydrated andosol, the effects of two experiments, by alternated 4 N HCl — 0.5 N, 100°C NaOH (fig. 16) and by 2 N HCl only (fig. 15), have been compared. An inferable interpretation of the dissolution diagrams has given the mineral composition (tableau III). In addition, the comparison of the dissolution curves for the three soil horizons shows the evolution of the weathering products along the soil profile.

In conclusion, the differential kinetics of dissolution by HCl and NaOH reagents can get a fairly good determination of weathering product in a andosol. However, this method needs to be adjusted by some variations in the conditions of use for reagents, in order to be sufficienty specific.

The better way, in any case of andosol, to obtain only the amont of the whole amorphous and para-crystalline products, is the use of the alternated 2 N HCl and 0.5 N — 25°C NaOH reagents. However, the variation in the conditions of each reagent can give a determination of intermediate phases of crystallized but fairly soluble minerals.

Finally the dissolution curves are meaningful for different types of andosols and could be more or less specific. Moreover, the comparison of the curves obtained on the various horizons of the same soil profile, can show the evolution of weathering products in the profile and therefore pedogenesis.

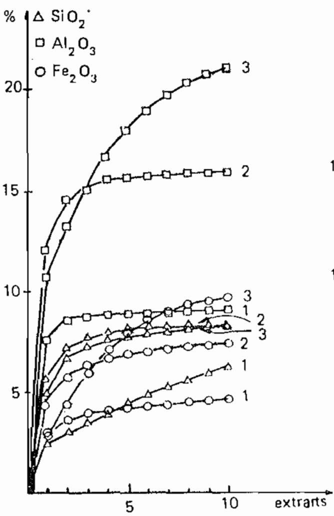

Fig. 14.

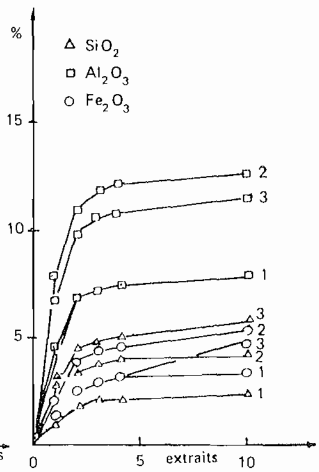

Fig. 15.

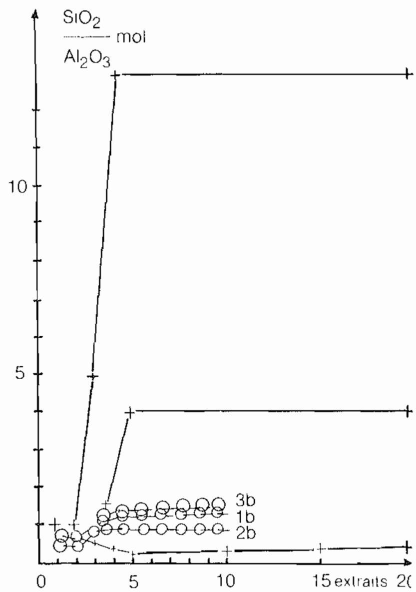

Planche VII : Dissolution of a rejuvenated perhydrated andosol.

Figure 14 : 4 N HCl/0.5 N NaOH (100°C) - 1 : A_1 hor. - 2 : (B) hor. - 3 : IIB hor.

Figure 15 : 2 NHCl only - 1 : A_1 hor. - 2 : (B) hor. - 3 : II B hor.

Figure 16 : a : 4 N HCl/0.5 N NaOH (100°C) - b : 2 N HCl mol. SiO_2/Al_2O_3 ratio 1 : A_1 hor. - 2 : (B) hor. - 3 : II B hor.