INFLUENCE OF LAYER CHARGE AND CHARGE DISTRIBUTION OF SMECTITES ON THE RHEOLOGICAL AND SWELLING PROPERTIES OF BENTONITES

CHRISTIDIS, G. E.,[1] BLUM, A. E.,[2] EBERL, D. D.[2]

[1] Department of Mineral Resources Engineering, Technical University of Crete [Μηχανικών Ορυκτών Πόρων, Πολυτεχνειο Κρητησ], Chania, 73100, Greece

[2] US Geological Survey, 3215 Marine St., Boulder (Co.), 80303, USA

E-mail: christid@mred.tuc.gr

Layer charge of smectites is of economic and geologic importance, because it strongly affects significant smectite properties such as swelling, cation exchange capacity and ion exchange selectivity. Although the inhomogeneity of smectite layer charge is well documented, the significance of layer charge distribution on important physical properties of smectites has not been studied in detail. In this contribution we present preliminary data on the influence of layer charge distribution of 23 well characterised smectites, having variable layer charge and charge distribution, on important rheological and swelling properties of smectites. Determination of the layer charge and charge distribution of smectites was obtained using the LayerCharge program (Christidis and Eberl, 2003). The program compares XRD traces of K-saturated, ethylene glycol solvated smectites with computer simulated XRD traces calculated for three-component interlayering. Determination of rheological properties was carried out using a 35S Fann Viscometer according to API specifications (API 13A, 1993). Free swelling volumes were determined on Na-activated smectites according to Christidis and Scott (1996).

The rheological properties (apparent viscosity, plastic viscosity, gel strength) and the swelling capacity are proportional to the fraction of low charge (17 Å) layers (Fig. 1) and inversely proportional to the fraction of high charge (10 Å) layers in the smectites (not shown). Although, in general, smectites with low layer charge display superior physical properties, the total layer charge is not related systematically to any of the physical properties examined. Two quasilinear trends can be observed in the smectites studied (Fig. 1). One trend in each figure comprises high charge smectites with both tetrahedral and octahedral charge and the second trend contains low charge smectites and high charge smectites with predominately octahedral charge (Otay-type montmorillonites). Both trends are characterised by scatter. The observed scattering is attributed to the variable tetrahedral charge of the smectites. Indeed, it is observed that with increasing beidellitic component (i.e. increasing tetrahedral charge) both rheological and swelling properties shift to lower values and thus deteriorate (Fig. 1).

A similar dual quasilinear trend is observed when other rheological or/and swelling properties of smectites are correlated. These trends also show the influence of layer charge inhomogeneity on the rheological and swelling properties of smectites. It is suggested that rheological and swelling properties of smectites are controlled by the proportion of the low charge layers and the proportion of tetrahedral charge.

References

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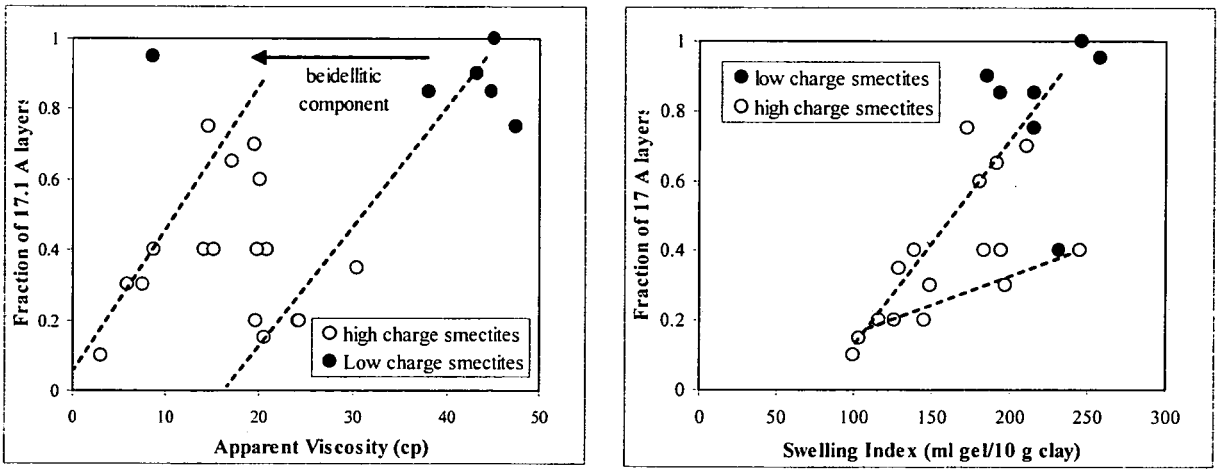

Fig. 1: Relationship between low charge layers and rheological and swelling properties of smectites.