CHARACTERIZATION OF BENTONITE PORE STRUCTURE BY COMBINING CHLORIDE POROSITY AND SAXS MEASUREMENTS

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The total water porosity, chloride porosity and the microstructure were studied in compacted samples prepared from MX-80 and Deponit bentonites equilibrated through filter plates with 0.1 M NaCl solution for 12.5 months. The dry densities of the samples varied approximately from 0.7 to 1.55 g/cm^3. XRD and SAXS (Small Angle X-ray Scattering) were used to study the microstructure of the bentonites.

It was obvious that the chloride porosity was lower than the water porosity in both clays, which indicates the exclusion caused by the negatively charged montmorillonite surfaces (Figure 1). In the XRD and SAXS measurements the measured basal spaces represented by the diffraction peaks were smaller than the theoretical ones assuming a homogenous microstructure. This indicates that there was a substantial amount of water also in the pores, which were not represented by the peaks (Figure 2). This could explain the difference between the measured chloride porosity and the modelling curve obtained with the Donnan model seen in Figure 1.

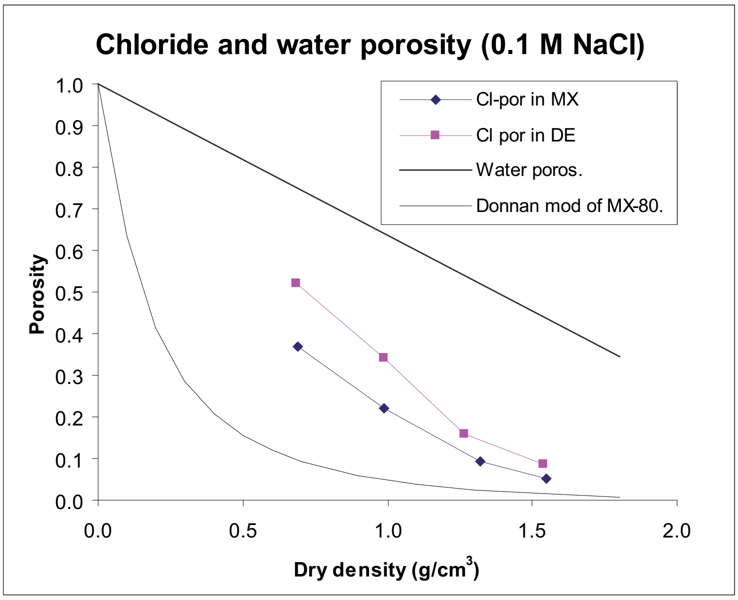

Figure 1: Chloride porosity and water porosity as a function of dry density in MX-80 and Deponit samples. The chloride porosity calculation based on the Donnan model is done only for MX-80 assuming a homogenous bentonite.

By combining the information from the SAXS measurements and the chloride exclusion measurements, it was possible to evaluate the volumes of the soft and dense fractions and the pore sizes in each fraction for MX-80 (Table 1). The chloride porosity was mostly caused by the pores in the soft clay where the pore size is larger. The volume of the soft fraction decreased and its density increased with increasing density of the sample.

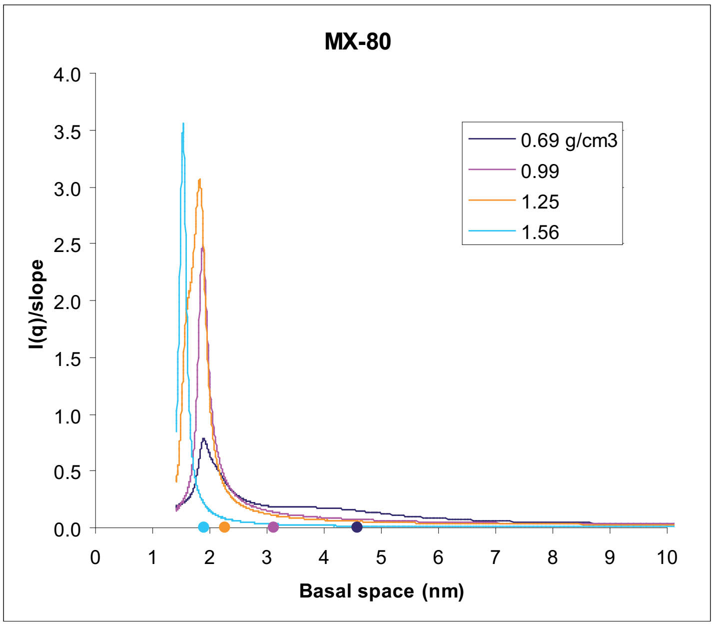

Figure 2: Modified SAXS scattering intensities of MX-80 samples as a function of the basal space. The I(q)-values have been divided by the slope of the curve at low q-values. The points on the x-axis show the theoretical basal spaces for different densities indicated in the legend.

Table 1: Results of the modelling of the porosities on the basis of the SAXS measurements and chloride exclusion experiments. The bentonite is assumed to be formed of dense and soft fractions

	MX10	MX11	MX12	MX13
Experimental results				
Dry density (g/cm^3)	0.69	0.99	1.25	1.55
Bulk density (g/cm^3)	1.44	1.63	1.80	1.99
Total water (g/cm^3)	0.749	0.640	0.545	0.436
Measured chloride porosity	0.37	0.22	0.09	0.05
Modelling results				
Water of soft clay fraction (g/cm^3)	0.457	0.307	0.216	0.125
Water of dense clay fraction (g/cm^3)	0.292	0.333	0.329	0.311
Contribution of dense fraction to chloride porosity	0.025	0.020	0.015	0.011
Contribution of soft fraction to chloride porosity	0.345	0.200	0.075	0.039
Volume of dense fraction (cm^3/cm^3)	0.532	0.682	0.760	0.860
Dry density of dense fraction (g/cm^3)	1.239	1.405	1.557	1.753
Volume of soft fraction (cm^3/cm^3)	0.468	0.318	0.240	0.140
Dry density of soft fraction (g/cm^3)	0.065	0.102	0.276	0.309
Effective basal space in soft fraction (Å)	495	322	118	105

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