Abstract No. dima386

Small-Angle X-ray Scattering from a Dense Na-Fluorohectorite Suspension

E. DiMasi (BNL), J.O. Fossum (Norwegian U. of Science and Technology), and K. Knudsen (Institute for Energy Technology (IFE), Norway)

Beamline: X10A

Introduction: Clay particles dispersed in salt solutions have been studied for decades, in part to learn how to control technologically important clay suspensions, and in part because of their geological significance. The concentration of the salt in solution, which controls the interactions between clay particles, is especially important. For example, “quick-clay” soils composed of illite particles, originally sedimented in salt water, can be destabilized by subsequent fresh-water rinsing; here, the consequence of reduced salt concentration is literally a sinkhole or landslide. Small-angle x-ray scattering can be used to obtain information about the particles in these important colloidal clay–salt water suspensions.

Methods and Materials: Naturally occurring clay soils are complex mixtures of minerals which can be difficult to model. Fortunately, chemically well characterized synthetic clays are available. For the present study, we used a 3.5 wt% solution of the synthetic clay Na-fluorohectorite dispersed in 1 mMolar NaCl. The sample was stirred and transferred to a thin-wall glass capillary of 0.5 mm diameter. Scattering data were obtained using the Bonse-Hart camera at beamline X10A. This system produces gravity-dispersed phases with dense sediments, gel and sol phases stratified in the sample tube [1,2], which were probed by positioning the beam at different heights.

Results: Normalized scattering data are shown in Figure 1(a) along with the background scattering curve obtained from a water-filled capillary. The steep drop observed at 2×10^{-3} Å^{-1} is a background feature observed even with no sample tube in the holder. The data for 2.5 mm and 4.0 mm show strong scattering, from the dense sediment phases. Positions higher in the tube, where the clay is more dilute, scatter much more weakly. The data are plotted as $\log[I\times q^2]$ vs q^2 in Figure 1(b). The scattered intensity begins to drop only at the smallest measurable q values, showing that the particles are quite anisotropic. Fits to the linear region of this Guinier plot in principle allow a radius of gyration to be extracted, assuming plate-like morphology of the particles. From these data we obtain a particle thickness of about 20A, more than an order of magnitude different from the 400–1600A thicknesses derived from Bragg scattering peak widths [2]. We believe the present data exhibit severe concentration effects in these dense sediments. Unfortunately the poor background subtraction for the weakly scattering dilute phases makes it impossible to analyze the less concentrated gel regions. Further measurements of the concentration dependence, using a spectrometer with coarser resolution, will probably be necessary.

Acknowledgments: We thank Steve Bennett and Rainer Kolb of ExxonMobil for assistance at X10A. J. O. Fossum acknowledges support from the Norwegian Research Council. The National Synchrotron Light Source is supported under USDOE contract DE-AC02-98CH10886.

References:

[1] J. O. Fossum, Physica A 270 (1999) 270.
[2] E. DiMasi, J. O. Fossum, T. Gog, and C. Venkataraman, Phys. Rev. E (to appear December 2001).

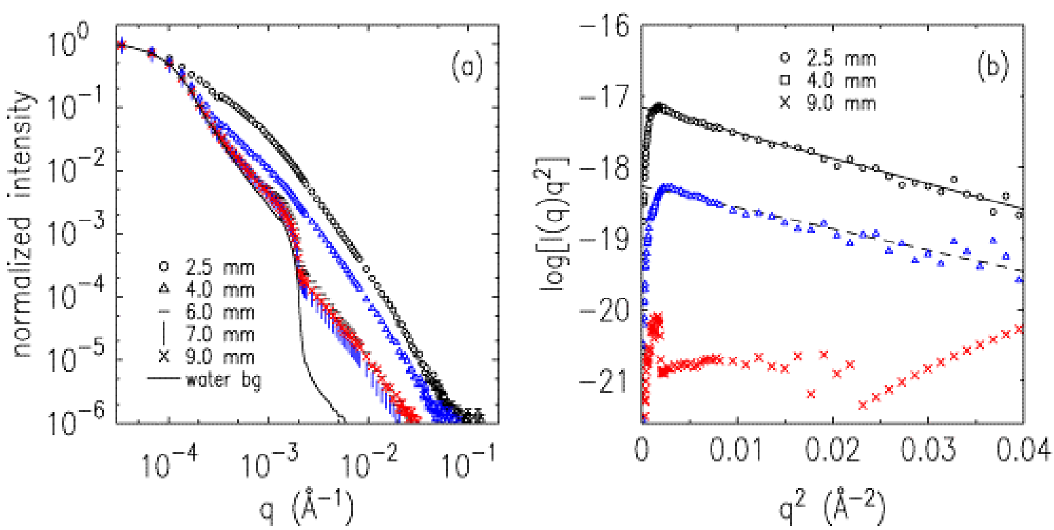

Figure 1. (a) Scattering curves obtained at various heights from the bottom of the sample tube.
(b) Guinier plot used to extract the radius of gyration.