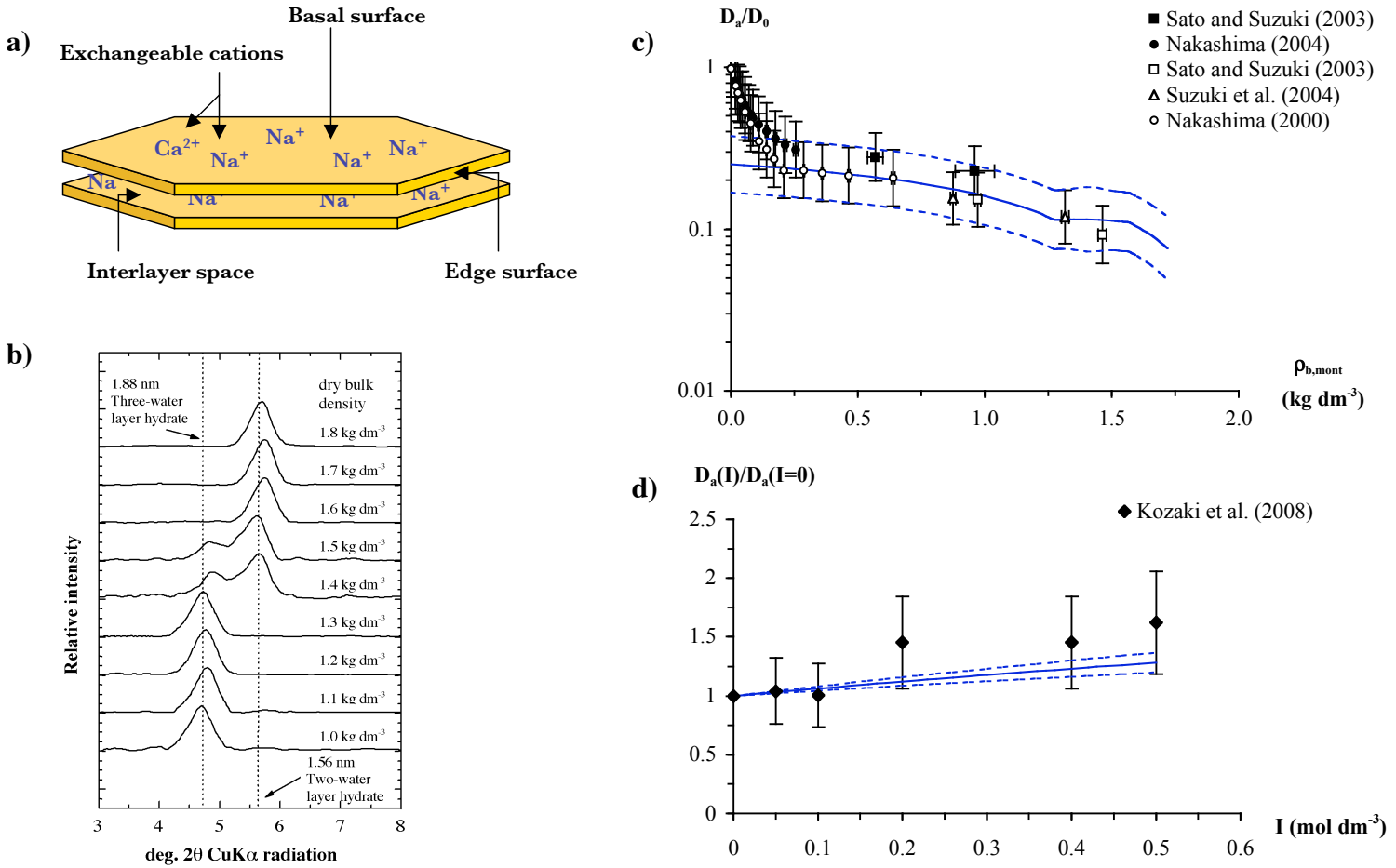

(a) Flake-shaped smectite lamellae form parallel stacking arrangements that create nanometer-thin "interlayer nanopores". **(b)** X-ray diffraction data (Kozaki et al., 1998) indicate that more than half of the pore space of smectite-rich porous media is located in these interlayer nanopores when the partial smectite dry density (the mass of smectite per volume of smectite and pore space) is greater than ~1 kg dm^{-3} (Bourg et al., 2006). We conceptually model diffusion in clay barriers as a weighted sum of diffusion terms in interlayer nanopore and macropore "compartments" of the pore space, with weighting by the mole fractions of the species of interest in these two compartments (Bourg et al., 2006, 2007, 2008). Our model successfully predicts all available data on the diffusion of water, Na^+ and Sr^{2+} in compacted water-saturated smectite clay barriers, including **(c)** the logarithm of the mean principal value of the apparent diffusion coefficient tensor of water as a function of partial smectite dry density (Bourg et al., 2006), and **(d)** the apparent diffusion coefficient of sodium, normalized to its value at background ionic strength $I = 0$, as a function of I (Bourg et al., 2008) (model predictions: solid blue curves, with confidence intervals shown as dashed blue curves).