Supplementary Material

This complementary document presents key variables and equations used in the paper.

Specific surface $S_S = A/M$ [m^2/g] is the ratio between the surface area of a particle A and its mass M. A plate-like clay particle (length L, width L, thickness $t \ll L$) has $A = 2L^2$ and mass $M = L^2 t\, \rho_m$ and specific surface $S_S = 2/t \cdot \rho_m$.

Void ratio $e = V_{void}/V_{solid}$ is the ratio between the volume of voids V_{void} and the volume of solids V_{solid}.

Pore diameter d_p can be estimated from granular packing. For example, the void ratio of dispersed plate-like particles (i.e., parallel configuration) is $e = d_p/t$. Therefore, a first-order-estimate of the mean pore diameter d_p is a function of void ratio e_z and specific surface: $d_p = e \cdot t = 2t/S_S \cdot \rho_m$.

Effective Stress Profile σ'_z with Depth z - Closed-Form Solution

Effective stress gradient $d\sigma'_z/dz$. Let's consider a seafloor slice of thickness dz at depth z. Force equilibrium combines with gravimetric-volumetric relations to predict the change in effective stress across the slice $d\sigma'_z/dz$ as a function of the void ratio e_z at depth z (Note: gravity g = 9.81 m/s^2):

$$\frac{d\sigma'_z}{dz} = \frac{(\rho_m - \rho_w)\, g}{1 + e_z} \qquad \text{(A-1)}$$

Compaction model. This study uses an asymptotically-correct exponential compaction model in terms of void ratios e_L at low effective stress ($\sigma'_z \to 0$) and e_H at very high effective stress ($\sigma'_z \to \infty$); then, the void ratio e_z at depth z is a function of the vertical effective stress σ'_z (Gregory et al. 2006; Chong and Santamarina 2016):

$$e_z = e_H + \left(e_L - e_H\right)\exp\left[-\left(\frac{\sigma'_z}{\sigma'_c}\right)^{\eta}\right] \tag{A-2}$$

Replacing Eq. A-1 in Eq. A-2, then the effective stress gradient $d\sigma'_z/d_z$,

$$\frac{d\sigma'_z}{dz} = \frac{\left(\rho_m - \rho_w\right)g}{1 + e_H + \left(e_L - e_H\right)\exp\left[-\left(\frac{\sigma'_z}{\sigma'_c}\right)^{\eta}\right]} \tag{A-3}$$

In general, this equation is numerically integrated. The common case of η = 1/3 leads to a closed-form solution, and the integration constant is resolved at the water-sediment interface where the effective stress is zero (i.e., σ'_z= 0 at z= 0):

$$z = \frac{\left(1+e_H\right)}{\left(\rho_m - \rho_w\right)g}\sigma'_z + 3\frac{\left(e_L - e_H\right)}{\left(\rho_m - \rho_w\right)g}\sigma'_c\left\{\left[\left(\frac{\sigma'_z}{\sigma'_c}\right)^{\frac{2}{3}} + 2\left(\frac{\sigma'_z}{\sigma'_c}\right)^{\frac{1}{3}} + 2\right]\cdot\exp\left[-\left(\frac{\sigma'_z}{\sigma'_c}\right)^{\frac{1}{3}}\right] - 2\right\} \tag{A.4}$$