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# Dewatering and consolidation of clay slurries

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Dewatering, which is the process of separating (colloidal) suspended particles from a solvent (usually water), is used in many engineering applications (sanitary engineering, dredging engineering…). Key questions associated with dewatering in the context of the reuse of dredged sediment are (1) what is the process kinetics, (2) how can these processes be optimized and (3) can the dewatered sludge be reused and for which application? Dewatering and consolidation are functions of the suspended particles' size and type, and their solvent-mediated interaction. In this presentation, some examples will be given about the dewatering of suspensions and slurries as found in engineering applications [1]. The presentation will focus on the behaviour of mineral clay suspensions (kaolinite, montmorillonite, illite…) composed of particles of different particle sizes [2-5]. We will show that, depending on the particle size distribution and solvent properties, the system is either undergoing a slow sedimentation dominated by thermodynamic forces or a rapid sedimentation dominated by gravity. The sedimentation is followed in time using NMR and inferential image analysis, and the particles are characterized by size, density and electrokinetic charge. We show that the time evolution of the sedimentation behaviour can be modelled using an advection-diffusion equation. The advective term is a function of gravity, whereas the diffusion term represents either a hard-sphere repulsion or an effective stress, depending on whether thermodynamic forces dominate the system [6-8]. We show that after solving this advection-diffusion equation numerically, the results based on the theory of Gibson does match the experimental data collected from NMR in the phase of slow kinetics. For the early stages of settling and consolidation, where the system kinetics are fast, we show that the data are contaminated by artifacts due to the limited time of signal acquisition imposed by the NMR method.  We show that is possible to overcome those limitations by either sacrificing some information related to particle's sizes using the NMR or by combining the NMR method with excess pore pressure measurements along the height of the settling columns.

### Contributor statement

The numerical code for settling and consolidation was developed by phd Ismail Myouri and Assistant professor Claire Chassagne. The measurements using NMR method was done by Assistant Professor Leo Pel. The data analysis was done by Phd Ismail Myouri and Post-doc Angela Casarella.

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### References

[1] Shakeel, A., Safar, Z., Ibanez, M., van Paassen, L., & Chassagne, C. (2020). Flocculation of clay suspensions by anionic and cationic polyelectrolytes: A systematic analysis. *Minerals*, 10(11), 999.
[2] Shakeel, A., Ali, W., Chassagne, C., & Kirichek, A. (2022). Tuning the rheological properties of kaolin suspensions using biopolymers. *Colloids and Surfaces A: Physicochemical and Engineering Aspects*, 654, 130120.
[3] Casarella, A., (2022) Multi-scale investigation of the thermo-mechanical behaviour of non-active clay, PhD thesis UGA
[4] Shakeel, A., Kirichek, A., & Chassagne, C. (2021). Rheology and yielding transitions in mixed kaolinite/bentonite suspensions. *Applied Clay Science*, 211, 106206.


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[5] Ibanez, M., Wijdeveld, A., & Chassagne, C. (2014). The role of mono-and divalent ions in the stability of kaolinite suspensions and fine tailings. *Clays and Clay Minerals*, 62(5), 374-385.
[6] Gibson, R. E., England, G. L., & Hussey, M. J. L. (1967). The theory of one-dimensional consolidation of saturated clays: 1. finite non-linear consildation of thin homogeneous layers. *Geotechnique*, 17(3), 261-273.
[7] Dhont, Jan KG. *An introduction to dynamics of colloids*. Elsevier, 1996.
[8] Chassagne, C. (2019). Understanding the natural consolidation of slurries using colloid science. In *17th European Conference on Soil Mechanics and Geotechnical Engineering*, ECSMGE 2019 (pp. 1-8). International Society for Soil Mechanics and Geotechnical Engineering.