Depositional Fabric inferred from Cryo-SEM Investigation of Gulf of Mexico Clay Slurries

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ABSTRACT

I show that plunge freezing destroys the fabric of clay slurries and creates an artificial honeycomb structure composed of clay aggregates joined together with face-edge contacts. The growing ice crystals push clay particles and salt ions to the boundaries, a process that leads to the formation of the observed honeycomb (Fig. 1). Furthermore, I utilize high pressure freezing and show that the real microstructure of clay slurries consists of individual clay particles and clay aggregates randomly distributed in frozen ice (Fig. 2). Unlike plunge freezing, high pressure freezing prevents ice crystallization and associated volume changes that alters the microstructure. These results demonstrate that one of the widely accepted models for clay slurries, the honeycomb structure, is an artifact of the plunge-freezing method and does not reflect the in-situ structure. In the field of geological sciences, this contrasts a fundamental view of fabric evolution that has inferred the presence of honeycomb structures that gradually evolve to an oriented fabric.

CLICK ON IMAGE FOR LARGER VIEW

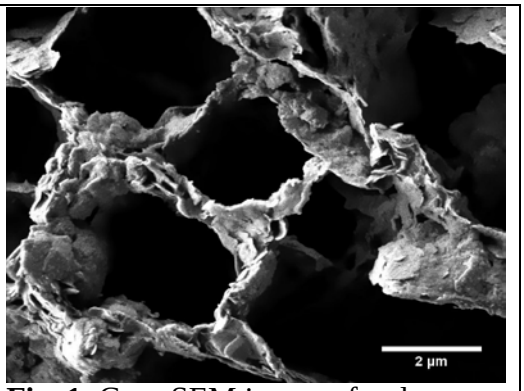


Fig. 1: Cryo SEM image of a slurry GOM-EI sample at a salinity of 64 g/l. The image shows the formation of a honeycomb structure upon the addition of salt. Vitrified pore fluid was removed by freeze-etching (sublimation); pore space therefore appears black. Walls between the pores are comprised of aggregated clay particles.

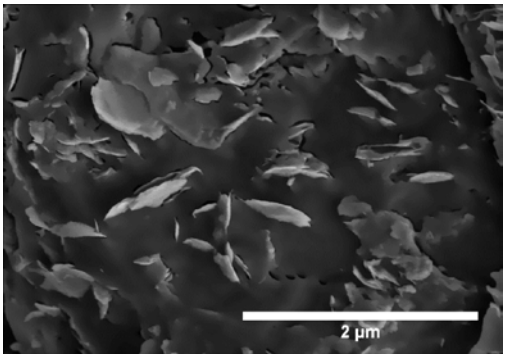
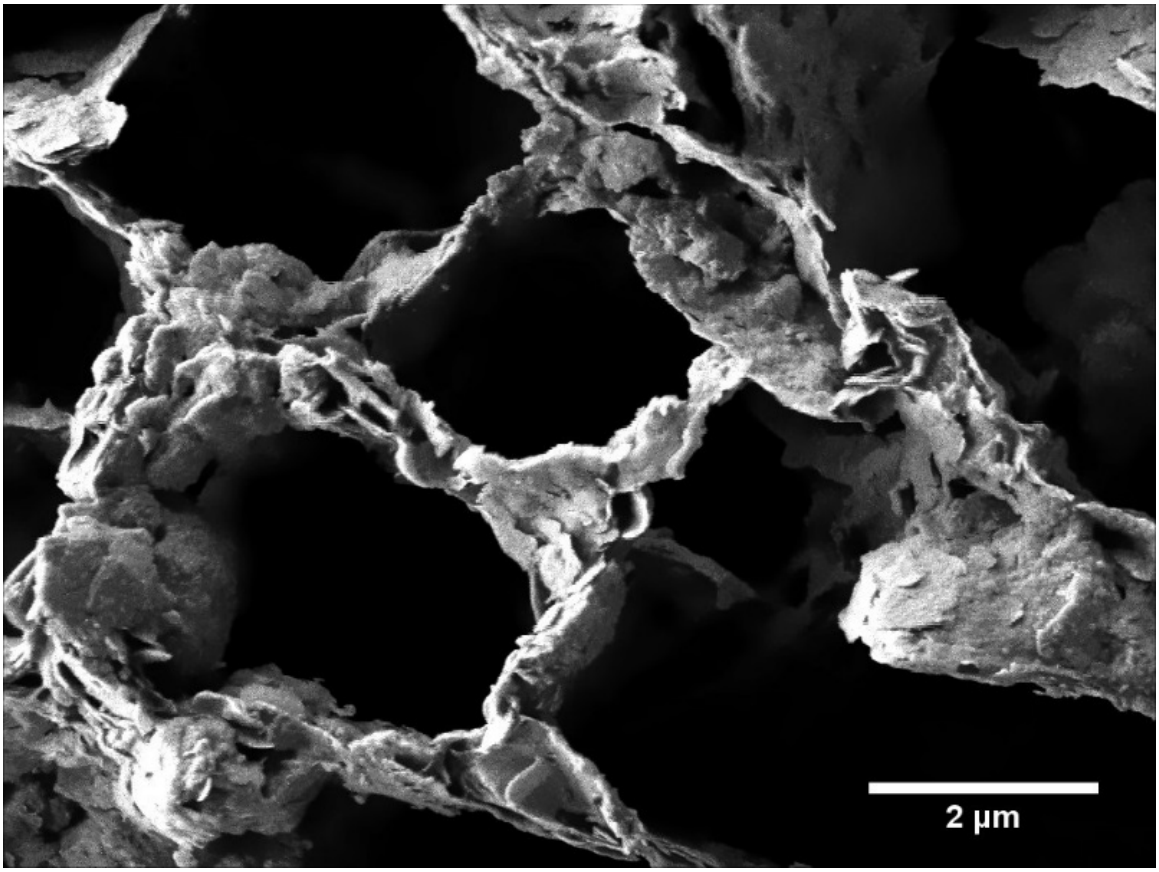


Fig. 2: Cryo-SEM image of a high-pressure-frozen GOM-EI clay slurry sample at 1 g/L. Dark grey represents frozen ice and light grey represents clay particles. The microstructure of clay slurries consists of clay particles and aggregates randomly distributed in a matrix of frozen ice.



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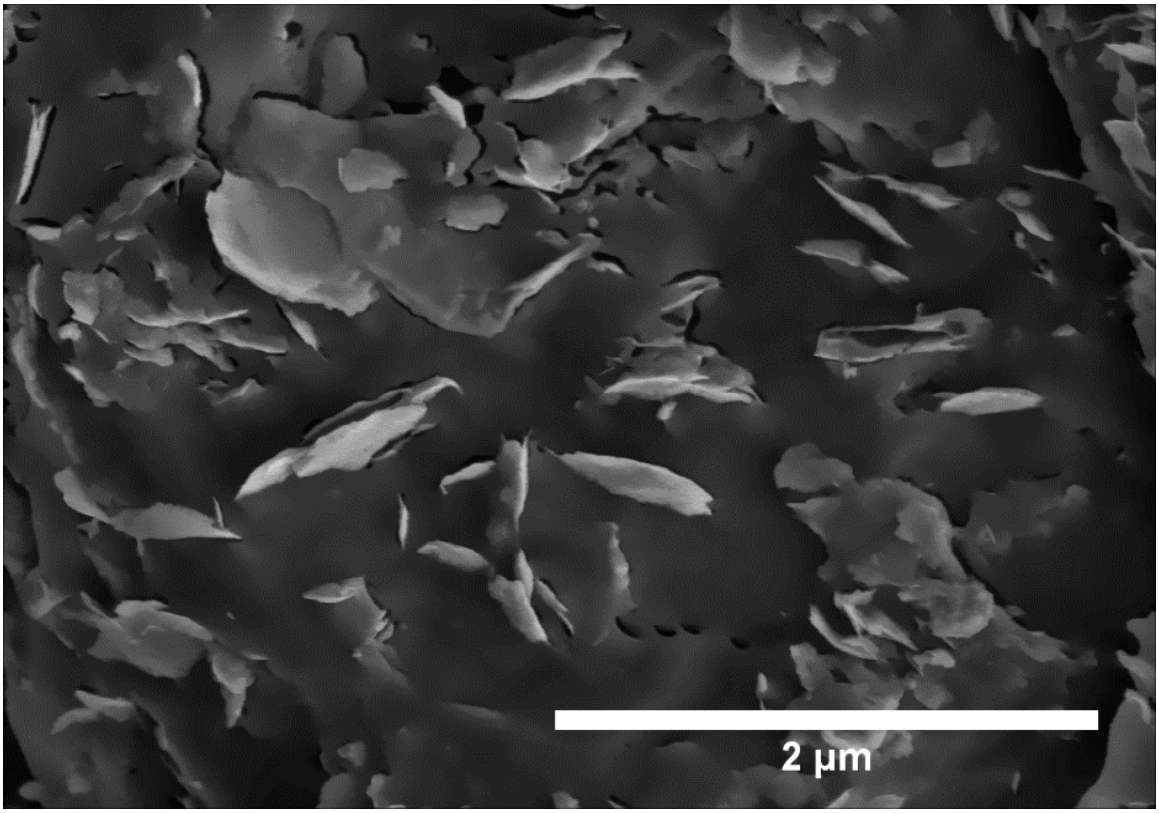

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