Chalk: composition, diagenesis and physical properties

Chalk is a sedimentary rock of unusually high homogeneity on the scale where physical properties are measured, but the properties fall in wide ranges. Chalk may thus be seen as the ideal starting point for a physical understanding of rocks in general. Properties as porosity, permeability, capillary entry pressure, and elastic moduli are consequences of primary sediment composition and of subsequent diagenetic history as caused by microbial action, burial stress, temperature, and pore pressure. Porosity is a main determining factor for other properties. For a given porosity, the specific surface of the sediment controls permeability and capillary entry pressure. As diagenesis progresses, the specific surface is less and less due to the calcite component and more and more due to the fine-grained silicates, as a reflection of the coarsening and cementation of the calcite crystals. The elastic moduli, which define sonic velocity, are for a given porosity mainly controlled by the degree of pore-stiffening cementation, which may be quantified by effective medium modeling. Diagenetic processes include mechanical compaction, pore-stiffening cementation, dissolution, and pore-filling cementation. Processes involving clay, silica, and calcite are interlinked, but progress differently in different localities. This partly depends on primary sediment composition, including organic content, which may induce the formation of concretions by microbial action. The diagenetic processes also depend on water depth, rate of burial, and over-pressuring. These factors cause the stress, temperature and pore-pressure to increase at different rates during burial in different localities.