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Chemically-induced jerky compaction of brittle porous media

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The degradation of materials due to chemical action has important consequences on soils, rocks and structures. For example the weathering of rock filled dams can lead to motion or collapse of the structure, through the intrusion of water inside cracks and fractures in the material. However full scale experiments of these effects are challenging due to the required high stresses and long time scales. Here we develop an experiment using puffed rice as a model material owing to its high brittleness and important susceptibility to water degradation. The material is placed under constant load and is partially soaked with water. A novel phenomenon of recurring compaction of the material due to water-induced softening is observed. Compaction events occur at a well defined rate, slowing down over time while lasting for hours. A simple model is derived based on the brittle properties of the grains, the evolution of their physical properties under water action, and the capillary rise of liquid in the pores of the material. The model allows to recover numerically and analytically the key characteristics of the time evolution of the compaction events as well as the creeping behaviour of the whole pack over time. The generality of the model and experiments gives significant insights toward a better understanding of chemically-induced collapse phenomena in natural or artificial porous materials like rocks, snow or foams.