MECHANICAL MEASUREMENTS REFLECT THE STRUCTURE OF A PARTICULATE MATERIALS

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Directional solidification of particulate materials takes place in many geological settings, at various scales, from millimeters in rocks to several kilometers on planetary surface (figure 1a). The mechanical properties of the resulting materials are strongly dependent on the solidification process. This process is investigated at the laboratory scale in modeled systems : the liquid-solid transition is caused by evaporation from a dispersion of silica colloidal particles in a volatile solvent. The transport of particles results in an aggregated, porous particle network. The mechanical behavior of this solid layer is investigated by indentation testing. Solid layers are found to exhibit non-homogeneous mechanical properties in depth (figure 1b) : The stiff is found to be larger at the drying surface (elastic modulus = 2 GPa) than at the bottom of the layer (elastic modulus = 0.75 GPa). We propose that the mechanical properties of the layer reflect the structure of the layer during the solidification. This particles distribution is well predicted by a numerical model based on the advection-diffusion process. This affects the crack formation and stability of crack propagation in the layer. As an evidence, we show that it is energetically less favorable for a crack generated inside a layer to propagate towards the stiffer region of the layer.

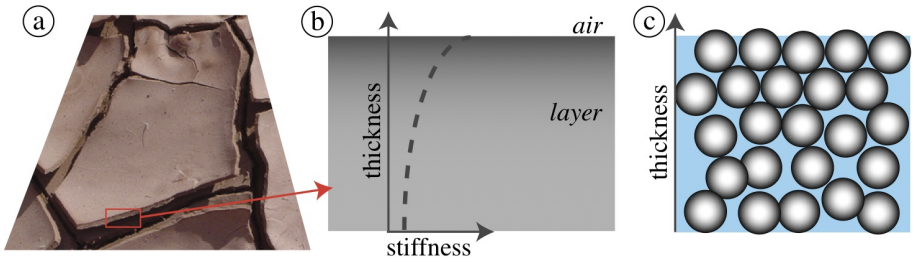

Figure 1. (a) Crack pattern in a drying mud (the polygons are approximately 30cm in length). (b) Non-uniform mechanical properties in the thickness of a layer. (c) The mechanical properties reflect the structure of a particulate material.