# Numerical study of drying process and columnar fracture process in granules-water mixtures

# Akihiro Nishimoto[1]; Tsuyoshi Mizuguchi[2]; So Kitsunezaki[3]

[1] Physics,Kyoto Univ; [2] Math.Sci., Osaka Prefecture Univ.; [3] Physics, Nara Women's Univ.

http://www.ton.scphys.kyoto-u.ac.jp/nonlinear/

Crack patterns are observed in everyday life. Columnar joint in cooled lava, especially, is an intriguing phenomenon and has fascinated many people for centuries. Recently, the patterns of cracks similar to columnar joint are investigated in the drying process of starch-water mixtures. During the drying process there are three stages. Stage 1: The water content decreases uniformly. Stage 2: Cracks are formed to extend to the bottom of the sample and a sudden change of water content occurs. These cracks have a uniform structure along the vertical direction and are refereed as type I cracks. Stage 3: The water content decreases slowly and the water content distribution becomes non-uniform, i.e., it has a "front". The front propagates inwardly and the mixture shrinks non-uniformly and another type of cracks, i.e., type II cracks are formed. The type II cracks show three-dimensional prismatic structure.

We investigate the formation of three-dimensional prismatic cracks in the drying process of starch-water mixtures by the computer simulation. We assume that the mixture is an elastic porous medium which possesses a stress field and a water content field. The evolution of both fields are represented by a spring network and a phenomenological model with the soil water potential, respectively. We find that the water content distribution has a propagating front which is hardly explained by a simple diffusion process. The prismatic structure of cracks driven by the water content field is observed. The depth dependence and the coarsening process of the columnar structure are also studied. The particle diameter dependence of the scale of the columns and the effect of the crack networks on the dynamics of the water content field are also considered.