Measurement of contact angles of aqueous solutions on solids and influence of surface roughness

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The wetting characteristics of fluids on rock surfaces are considered to have a prime role in the fluid flow in polycrystalline rocks controlling Earth's Dynamics.

Although the wetting behavior of industrial materials have been widely examined often by contact angle measurements, wetting properties of rock-forming materials have not been commonly investigated to understand Earth's dynamics. The contact angle is one of the basic wetting properties which can be measured relatively easily. Therefore, contact angles for earth's materials have been measured first on a simple system such as slide glasses. Since the actual rock surface is not smooth, changes in the contact angle with the surface roughness were evaluated.

Water droplets from a micropipette are placed on solid surfaces by moving up the sample stage. Images of water drops are captured from a horizontal direction with a CCD camera. Contact angles can be determined from height a and contact diameter b of water drops on solids by assuming them to be parts of circles. First, effects of surface washing and evaporation of the water drop were examined. Atmospheric dusts appeared to be adsorbed on solid surfaces when leaving them in the atmosphere for a long time. It is necessary to measure contact angles quickly after the washing. The surfaces of the slide glass were smooth within several nm by atomic force microscope (AFM) measurement. Pure water drop of about 1.5 micro liters on the slide glass was found to be completely evaporated within about 20 minutes (relative humidity: 60%, temperatures: 22C). The evaporation effects can be neglected by the contact angle measurement rapidly after the drop placement on solids. The contact angle of pure water on the slide glass was determined to be about 60 degrees.

Next, the slide glass surface was treated with the emery paper or the grinding powder for changing their surface roughness. The contact angles of pure water on these surface-treated slide glass samples were measured. The contact angle became smaller with increasing surface roughness, resulting in the increasing wetting of the slide glass. This result can be explained by the equation of Wenzel describing that the contact angle depends on the ratio of an apparent surface area to a true surface area. Contact angles of various aqueous solutions with different chemical compositions will be measured on some representative minerals by controlling their surface roughness in order to evaluate wetting properties of natural rock-water systems.