

New insights on the hydration of the zeolite laumontite: a natural nano-sponge

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Laumontite, $[(Ca_{4-x}Na_x)K_x(H_2O)_n][Al_8Si_{16}O_{48}]$, space group $C2/m$, is one of the most common natural zeolite occurring in a wide range of geological environments, including sedimentary deposits and deep-sea sediments. Remarkably, it is also present in oceanic basalts as well as in vugs of plutonic and volcanic rocks and in sedimentary rocks. Fully hydrated laumontite contains 18 H₂O molecules per formula unit, although it can lose up to 4 H₂O molecules per formula unit if exposed to air at relative humidity RH < 50%. Such a partially-dehydrated laumontite is formally referred as leonhardite (Yamazaki et al., 1991).

To date, laumontite has been studied mainly *via* X-ray powder diffraction, in order to investigate the processes of hydration/dehydration controlling the RH or submerging samples in pure water or increasing temperature (*e.g.*, Yamazaki et al., 1991; Fridriksson et al., 2004). Lee et al. (2004) investigated the high-pressure behavior of laumontite up to 7.5 GPa, by *in situ* synchrotron powder diffraction with a diamond anvil cell, using the 16:3:1 methanol-ethanol-H₂O pressure medium, and observed an instantaneous over-hydration effect at a relatively low pressure (< 0.5 GPa) with a potential additional phase transition at about 3 GPa (Lee et al., 2004). However, a number of open questions remain still open about: i) the possible phase transition observed by Lee et al. (2004) at about 3 GPa, ii) the elastic parameters of leonhardite, which both thermodynamic calculation and geological observations suggest being the stable form of laumontite under diagenetic and low- grade metamorphic conditions (*e.g.*, Neuhoff & Bird, 2001; Coombs et al., 1959), and iii) the single-crystal hydration kinetics in H₂O mixture. These parameters are critical considering the fact that laumontite is one of the most common zeolite in the oceanic basalts and, thereby, it can be an important H₂O-carrier in subduction zones. In this light, we performed *in situ* single-crystal synchrotron X-ray diffraction experiments using different pressure transmitting fluids, as well as a number of *in situ* single-crystal experiments at ambient pressure in different H₂O rich-mixture. On the basis of these studies, we are able to describe: 1) the hydration mechanisms and kinetics of laumontite in large single-crystals, 2) the bonding configuration of the adsorbed H₂O molecules and the structural deformation of the framework in response to the overhydration at ambient pressure; 3) the elastic parameters of leonhardite; 4) the different deformation behavior between leonhardite and the hydrated-laumontite.

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