Effect of particle size on themal stability of nanoscale minerals

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The nanoscale minerals can be formed in diverse geological environments through geochemical, biological and mechanical processes. The probing of the effect of particle size on the dehydration and/or temeprature-induced phase transition is essential to understands geological processes in the earth. In this study, the thermal stability of nanoscale minerals including alumina, talc, and zeolites are reported with varying nano-scale particle size. High-resolution solid-state ^{1}H nuclear magnetic resonace(NMR) spectra provides quantitative changes in the atomic structure of hydrous species on the surface of minerals upon *ex-situ* heating. The water content in nanoscale mineral significantly incresases with decreasing particle sizes. With increasing heating temeprature, these hydrous species significantly decreases in order of physically adsorbed water, chemisorbed water, and hydroxyl groups. The phase transition also be observed with dehydration as shown in ^{27}Al NMR spectra and XRD patterns. The lower dehydration temperature and thermal phase transition temperature are observed for the smaller sized minerals. These results indicate that the dehydration of hydrous species on the surfece induces the lower phase transition temperature for nanosclae minerals than macroscale and bulk minerals. Higher water content, lower dehydration temperature and thermal phase transition temperature in nanoscale mineral compared to bulk mineral suggests that nanoscale minerals in fault gauge (e.g., mylonite) may play an important role in reducing the fault friction by retaining hydrous species on the surface.