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Water uptake and hygroscopicity of perchlorates and implications for the existence of liquid water in some hyperarid environments

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The existence of liquid water is a prerequisite for habitability. Deliquescence of perchlorates under subsaturated conditions has been proposed to explain the occurrence of liquid water in some hyperarid environments on the earth and on the Mars. However, the amount of liquid water associated with perchlorates under different conditions has not been well understood yet. In this work, we have measured deliquescence relative humidity (DRH) of three perchlorates at different temperatures from 278 to 303 K. DRH decreases from (42.8±0.6)% at 278 K to (40.5±0.5)% at 303 K for $Mg(ClO_4)_2$•$6H_2O$, and from (18.5±0.5)% at 278 K to (15.5±0.5)% at 303 K for $Ca(ClO_4)_2$•$4H_2O$; in contrast, deliquescence of $KClO_4$ did not occur even when RH (relative humidity) was increased to 95%. In addition, we have determined the amount of water taken up by $Ca(ClO_4)_2$•$4H_2O$ and $Mg(ClO_4)_2$•$6H_2O$ as a function of RH (0-90%) and temperatures (278-298 K). It is found that when both salts are deliquesced, more water ($\sim$10% on average) is associated with $Mg(ClO_4)_2$•$6H_2O$ than $Ca(ClO_4)_2$•$4H_2O$ on the per mole ClO_4^- base. Overall, this work would significantly improve our knowledge in hygroscopicity of perchlorates, and thus may provide fundamental insights into the hydrologic cycles in some hyperarid regions on the earth and on the Mars.