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Hydration state and abundance of zeolites and the water cycle on Mars

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Recent experimental studies showed that zeolites, if present on the martian surface, could undergo a strong diurnal cycle of hydration and dehydration with possible impact on the atmosphere. This study evaluates this possibility using a global model of hydration/dehydration of two types of zeolites (clinoptilolite and chabazite) assuming actual diurnal, seasonal, and geographical temperature variations. If zeolites extensively cover the surface and undergo complete diurnal hydration/dehydration cycles as predicted from the water vapour adsorption isotherms, the resulting water content would be too high both in the surface material and atmosphere, implying that the abundance of zeolites is low or zeolites must exist in a more desiccated state. If the zeolite abundance is low with the same hydration behaviour, the lowest mean surface water content would occur at the equator, which also does not agree with observations. If substantial hydration/dehydration occurs seasonally rather than diurnally, the latitudinal and seasonal variation of the water content becomes too large and the zeolite abundance would have to vary with season to match the observation, which is also unrealistic. The most realistic scenario is a diurnally and seasonally constant low hydration state of zeolites controlled by the annual maximum surface temperature, in addition to a low abundance. Using these assumptions, the global distribution of the water content in the near-surface dry layer inferred from Mars Odyssey high-energy neutron detector (HEND) data can be roughly explained. The best guess for the zeolite abundance in the surface material to account for the observed water content is, on global average, $\sim$30 % for Ca-clinoptilolite, $\sim$35 % for Na-clinoptilolite, $\sim$55 % for K-clinoptilolite and $\sim$15 % for chabazite *if no other hydrated minerals are present.* However, with a globally uniform zeolite abundance the model underpredicts the wa-

ter content in dust-covered Arabia and Tharsis areas, indicating the zeolite abundance should be somewhat higher in the surface dust than elsewhere. In any case, the diurnal atmospheric water cycle is unlikely to be affected by zeolites on the surface. Zeolites directly exposed to the atmosphere may undergo some seasonal hydration and dehydration, though, but without significantly changing the soil water content and with a small influence on the atmospheric water cycle.