

Water Formation and Release via Thermal Desorption on and within Hydroxylated Lunar Mare and Highland Samples. Thomas M. Orlando^{1,2,3}, Brant M. Jones¹, Alexandr B. Aleksandrov¹, Charles A. Hibbitts⁴ and M. Darby Dyar⁵, ¹School of Chemistry and Biochemistry, Georgia Institute of Technology, Atlanta, Georgia, ²School of Physics, Georgia Institute of Technology, Atlanta, Georgia, ³Center for Space Technology and Research Biochemistry, Georgia Institute of Technology, Atlanta, Georgia, ⁴Johns Hopkins University Applied Physics Laboratory, Laurel, Maryland, ⁵Mount Holyoke College, Department of Astronomy, South Hadley, Massachusetts

Introduction: The desorption activation energies of water molecules chemisorbed on highland and mare Apollo lunar samples of different maturity levels and chemical compositions were determined by temperature programmed desorption (TPD) experiments in ultra-high vacuum. A significant difference in the uptake and abundance of adsorbed water was observed, with mare samples retaining up to 6 times less water (by mass) than typical highland samples. The difference between the samples is likely due to differences in mineralogy and surface exposure age. The coverage dependent desorption activation energies were extracted using an inversion method [1]. Generally, the distribution function of water desorption activation energies was similar for both mare and highland samples with a peak binding energy near 0.7 eV and a very small occupancy of sites up to 0.9 eV. In addition, we have also examined the formation and release of water from the same lunar samples via a second order thermal process known as recombinative desorption. In this process, surface OH sites and internal OH defects near each other react and produce water while healing the non-bridging oxygen defect. The derived second order activation energies for sample 10084 were as low as 0.8 eV in the high coverage limit extending upward near 1.8 eV at very low coverage. Knowledge of these activation energies is critical in understanding and thus predicting the diurnal behavior and latitude evolution of water on the surface of the Moon.

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References:

1. Tait, S.L., et al., *n-Alkanes on MgO (100). I. Coverage-dependent desorption kinetics of n-butane*. The Journal of chemical physics, 2005. **122**(16): p. 164707.