METEORITE MODELS OF ASTROCHEMISTRY AND ASTROBIOLOGY. 1. GAS/GRAIN INTERACTIONS AND CATALYSIS IN THE SOLAR NEBULA Michael N. Mautner, Department of Chemistry, Virginia Commonwealth University, Richmond, VA 23284. (mmautner@vcu.edu)

Introduction: Carbonacous chondrite meteorites preserve materials from the early Solar System. These materials are useful for the experimental modeling of nebula processes, including gas/grain adsorption, and catalysis on solid surfaces and in solution. [1,2]

Experimental Methods: The studies used powderized samples of the Allande CV3 and Murchison CM2 meteorites. Adsorption isotherms for N_2 were constructed by equilibrium pressure determination, and for H_2O by gravimetric analysis of adsorption. Catalysis was studied by gas flow over heated meteorite powders and mass spectrometric monitoring. Catalysis in solution was studied by processing of solutions at 0 - 100 C with and without powdered meteorite catalysts, followed by GCMS product analysis.

Gas/Grain Adsorption: In the nebula, adsorption on dust grain surfaces can control the partial pressures of gases. In this respect, isotherms were constructed for the adsorption of water vapor and N_2 on Murchison CM2 and Allende CV3 materials. The isotherms yielded heats of adsorption of 56.5±2.5 kJ/mol for H_2O on Murchison. [1] Temperature programmed desorption of CO yielded a binding energy of 13.5±3.0 kJ/mol to Murchison-based nanoparticles, vs. 9.8±0.2 kJ mol^{-1} for binding to ice. [2] These data are used to construct adsorption isotherms for diverse and extreme nebula pressures and temperatures.

Surface Catalysis: The oxidation of CO to CO_2 can occur in the Solar Nebula by O atoms produced by CO photodissociation on carbonaceous chondrite surfaces. Experimentally, the Murchison materials that contain clay-like constituents, catalysed CO/CO_2 conversion with a lower onset temperature than Allende materials. We also observed that acetaldehyde (CH_3CHO) is oxidised to form acetic acid (CH_3COOH) on Allende meteorite surfaces. [3] Similarly, surface-catalyzed oxidation of C_2H_2 and H_2CO on carbonaceous chondrite surfaces may convert them into other known astrochemical molecules such as HC=CHO or H_2C=C=O, H_2C=CHOH respectively.

Catalysis in Solution: Catalyzed reactions in solution can occur in carbonaceous asteroids during aqueous alteration, or in meteorite pores on aqueous planets. For model reactions, we processed solutions of astrochemical molecules including NH_3, HCN, CH_3OH, H_2CO, CH_3CHO and CH_3CN in the presence of Allende and Murchison catalysts, and found complex organic products. These products suggest that solutions in carbonaceous chondrite pores could form complex prebiotic organics.

Future Work: Materials from the early Solar System, delivered by meteorites, can be used to model the astro-physical chemistry of Solar Nebula procesess. Such modeliong was demonstrated by adsorption isotherms, gas/solid binding energies, and catalysis on particle surfaces and in solution. Similar studies can be extended to a wide range of chemical components and processes involving solids in interstellar clouds and in solar nebulae, and extrapolated to the wide range of conditions that prevail in these environments.

References: [1] Mautner M. N. (2002) *Icarus, 158,* 72-86. [2] Mautner, M. N. et. al. (2006) *Faraday Discussions, 133,* 103 – 112. [3] Abdelsayed et. al. *AIP Conf. Proc. 855 R. A.Kaiser et. al. Eds.*

Figure 1. Adsorption isotherms of water on the Murchison meteorite at 278, 293, and 311 K. Inset shows low pressure points at higher resolution.