GUANINE, ADENINE, AND HYPOXANTHINE PRODUCTION FROM UV-IRRADIATED FORMAMIDE: RELAXATION OF THE REQUIREMENTS FOR PREBIOTIC PURINE NUCLEOBASE FORMATION. T. M. Orlando[1,2], H. Barks[1], R. Buckley[1], G. Greives[1], E. DiMauro[3], and N. V. Hud[1], [1]School of Chemistry[1] and Biochemistry and School of Physics[2]Georgia Institute of Technology, Atlanta, GA 30332 Dipartimento di Genetica e Biologia Molecolari, Universita "Sapienza"[3]Roma 00185 Italy, Thomas.Orlando@chemistry.gatech.edu

Introduction: Since solution conditions were prevalent on early Earth and impact melt zones could have existed on Titan, we have carried out solution-phase photochemical production studies of nucleobases from formamide (NH_2CHO); the simplest C, H, N and O bearing molecule.

Results: We observe the production of adenine, hypoxanthine, and guanine in heated and UV irradiated formamide solutions. These "one pot" reactions occur due to the synergy of thermal and UV photon-induced processes. The nucleobase yields are enhanced and the product distribution changes when minerals (or their dissolved ions) are present. Mechanistic pathways and the possible roles of diaminomaleonitrile (DAMN), aminomidazolecarbonitrile (AICN), and aminoimidizolecarboxamide (AICA) as intermediates in these reactions are examined. Adenine production is enhanced when DAMN or AICN is added to a formamide solution prior to heating and/or UV irradiation, and hypoxanthine production is enhanced when AICA is added.

In view of the important role of minerals, we have begun initial surface chemistry investigations. Specifically, attenuated total reflection and infrared reflection absorption spectroscopy (IRAS) are being used in conjunction with controlled low-energy electron and UV photon bombardment. Thus far, we have studied the condensation and reactions of formamide using: kaolinite ($Al_2O_3\ SiO_2(OH)_4$), libethenite ($Cu_2(OH)PO_4$), monobasic sodium phosphate ($NaH_2PO_4 \cdot H_2O$), and tribasic sodium phosphate (Na_3PO_4). Phosphorous containing minerals have been chosen since they can also lead to phosphate incorporation and eventually the formation of small nucleotides [1] and microRNAs. In general, we have found that reactions leading to nucleobase formation are extremely slow at low temperature but are indeed catalyzed by UV radiation and minerals. The results presented generally suggest that the prebiotic formation of purine nucleobases is more likely than previously demonstrated.

References:

[1] R. Saladino, C. Crestini, G. Costanzo, and E. DiMauro, (2005) *Top. Curr Chem, 259,* 29-68.