EXPERIMENTAL STUDIES OF THE SPUTTERING OF MIXED ICES: EUROPA'S SURFACE COMPOSITION AND DETECTION OF TRACE SPECIES BY SURFACE SPUTTERING

R. W. Carlson[1] and K. P. Hand[1], [1]Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA 91109 (Robert.W.Carlson@jpl.nasa.gov)

Introduction. Nature's ubiquitous high-energy radiation serves conflicting roles in our search for life beyond Earth. While generally considered harmful, radiation may also be beneficial, producing the organic compounds that sparked life and producing chemicals that may support microorganisms. Similarly, our search for life on other worlds may be complicated by radiolytic modification of biomolecules, but that same radiation could also provide a means – by sputtering - for biosignature detection from orbit.

Sputtering and Detection of Surface Material. Europa's surface may contain material upwelled from the ocean below, and if there is extant life within Europa's ocean, then diagnostic biomarkers may exist on Europa's surface. Naturally occurring intense ion bombardment constantly ejects these molecules by a process known as sputtering and can be used to infer surface composition, as first pointed out by Johnson et al in 1998 [1]. They suggested that Europa's surface molecules, including large whole organic molecules, could be investigated by detecting molecules sputtered from the surface that are subsequently photoionized and observable using an orbiting ion mass spectrometer. One can also envision detecting the more plentiful neutral sputter products with a neutral mass spectrometer or by remote sensing of the sputtered atmosphere through mm-wave rotational line spectroscopy, for example. The latter method allows detection of large molecules that do not reach orbital altitudes.

A New Experimental Program. Although there have been many studies of sputtering multi-component metals, there have been few studies of the sputtering of molecules mixed in ice, particularly for those biomolecules of astrobiological interest. Theoretical estimates for the yields indicate different low-cascade density, high-cascade density, and thermal pulse sputtering. Furthermore, the velocity profiles of each ejected species are unknown and must be determined in order predict their altitude distribution and thereby relate a local or column measurement to the surface composition.

Our newly started experimental program determines the yields, molecular fractionation patterns, and velocity distributions of sputtered biosignature molecules in ice. Our current experiments are being performed with a 5-keV pulsed ion gun (Hiden !G20) with time-resolved positive ion, negative ion, and neutral sputter-product determinations employing a quadrupole mass spectrometer (Hiden IDP) and multichannel scalar. Both unirradiated and electron-irradiated biosignature molecules in ice ([2], simulating Europa's surface and radiation environment) are being studied, and results will presented.

[1] Johnson, R. E., et al., 1998. *Geophys. Res. Lett.* **25,** 3257-3260. [2] Hand, K. P. and Carlson, R. W., this Conference