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Measuring Planetary Composition at Depth: Neutron Measurements at Ganymede

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A key aspect of understanding planetary surface compositions is having knowledge of composition variability at different depth scales. Spectral reflectance techniques are sensitive to compositional variations at the top tens of microns of a planetary surface. Spectral reflectance measurements can consequently be affected by surface effects that may mask compositional information present at larger depth scales. Radar sounding techniques provide compositional information for depth scales for 10 – 100s of meters but may not provide robust compositional information for depths shallower than 1 meter. Between these two depth scales, orbital neutron spectroscopy probes tens of centimeters beneath a planetary surface. Orbital neutron spectroscopy therefore provides complementary and unique composition information for layering deposits on planetary surfaces. Studies of the depth sensitivity of neutrons have been carried out for both the Moon and Mars. The depth to which neutrons are sensitive is generally dependent on hydrogen content. Lower hydrogen contents allow larger depths (up to $\sim$100 cm) to be probed. At the Moon, orbital neutron data indicate that hydrogen deposits at the lunar poles are covered by a dry layer that is $\sim$20 – 30 cm thick. On Mars, thermal, epithermal, and fast neutrons are returning quantitative information for the thickness and hydrogen content of dry layers that overlie wet, permafrost-like lower layers. Orbital neutron measurements on the Jupiter Ganymede Orbiter (JGO) should provide similar depth-dependent composition information for Ganymede. In particular, neutron measurements can provide quantitative information regarding the hydrogen concentration and thickness of layered deposits such as lag deposits or surfaces modified by charged particle deposition and sputtering. We will present results from a study where we investigate the depth dependence of neutrons for various water contents and elemental concentrations relevant to Ganymede. We will describe how such measurements are applicable to the science goals for the upcoming JGO mission.