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In Situ Instrumentation for Sub-Surface Planetary Geochemistry

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Instrumentation Development

Novel instrumentation is under development at NASA's Goddard Space Flight Center, building upon earth-based techniques for hostile environments [1,2], to infer geochemical processes important to formation and evolution of solid bodies in our Solar System. A prototype instrument, the Pulsed Neutron Generator – Gamma Ray and Neutron Detectors (PNG-GRAND), has a 14 MeV pulsed neutron generator coupled with gamma ray and neutron detectors to measure quantitative elemental concentrations and bulk densities of a number of major, minor and trace elements at or below the surfaces with approximately a meter-sized spatial resolution down to depths of about 50 cm without the need to drill. PNG-GRAND's *in situ* meter-scale measurements and adaptability to a variety of extreme space environments will complement orbital kilometer-scale and *in situ* millimeter-scale elemental and mineralogical measurements to provide a more complete picture of the geochemistry of planets, moons, asteroids and comets.

Preliminary Testing and Results

We are optimizing the PNG-GRAND instrument configuration and refining our analysis techniques through experimentation at our unique outdoor test facility. We will present results (Fig. 1) that demonstrate PNG-GRAND's capabilities for elemental composition measurements.

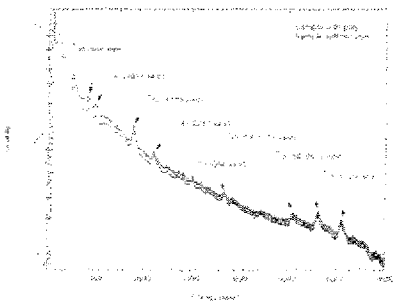

Figure 1. Gamma ray spectra obtained with PNG-GRAND on a 2x2x2 m granite structure with and without a simulated water layer.

[1] Grau *et al.* (1993) *Nucl. Geophys.* **7**, 173-188. [2] Schweitzer (1993) Subsurface Measurements for Geochemical Analysis. In *Remote Topics in Remote Sensing 4* (eds. Pieters and Englert). Cambridge Univ. Press, Cambridge. pp. 485-505.