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Elemental Composition of the Lunar Surface: Analysis of Gamma Ray Spectroscopy Data from Lunar Prospector

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Gamma ray spectroscopy (GRS) data acquired by the Lunar Prospector (LP) bismuth germinate (BGO) detector are analyzed to determine the elemental composition of the lunar surface. Maps of the abundance of major oxides, including TiO2, FeO, MgO, Al2O3, and radioactive elements, including K and Th, are presented along with their geochemical interpretation. Linear spectral mixing is used to model the observed gamma ray spectrum for each map pixel. The spectral shape for each elemental constituent is determined by a Monte Carlo radiation transport calculation. Linearization of the mixing model is accomplished by scaling the spectral shapes by quantities, including neutron number density and effective atomic mass, determined by neutron spectroscopy. The association of highlands geological units with the feldspathic lunar meteorites is used to calibrate the model. The present analysis uses new gamma ray production cross sections for neutron interactions, resulting in improved accuracy compared to previous evaluations submitted to the Planetary Data System. Systematic variations in lunar composition determined by the spectral unmixing analysis are compared with the lunar soil sample and meteorite collections. The performance of the BGO spectrometer is discussed along with implications for the design of the GRS for the Dawn mission to (1) Ceres and (4) Vesta.