Compositional Stratigraphy of Crustal Material from Near-Infrared Spectra

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The walls and ejecta surrounding large impact craters 40-100 km in diameter expose the first few kilometers of crustal material at the target site just below the surface. Central peaks of such craters expose material derived from greater depths (~4 - 10 km) [eg. Grieve and Head, LPSC 14]. High spatial resolution measurements of the composition of material associated with such craters can be used to probe the subsurface crust. An earth-based telescopic program to acquire near-infrared spectra of freshly exposed lunar material now contains data for 17 large impact craters with central peaks. Noritic, gabbroic, anorthositic and troctolitic rock types can be distinguished for areas within these large craters from characteristic absorptions in individual spectra of their walls and central peaks. Norites dominate the upper lunar crust while the deeper crustal zones also contain significant amounts of gabbros and anorthosites. Examples of the compositional stratigraphy of the lunar highland crust observed at specific craters include (subsurface crust - deeper crust):

Aristarchus: gabbro + troctolitic gabbro - gabbro [Lucey et al LPSC 16]
Bullialdus: gabbro - norite
Copernicus: norite - troctolite [Pieters et al, *JGR 90*, 12,393]
Eratosthenes: norite - gabbro
Langrenus: norite throughout
Lansberg: norite - norite (with clinopyroxene)
Theophilus: norite - anorthosite
Tycho: gabbro throughout

When the complexity of planetary crusts are compared, the Moon is often considered a relatively simple and homogeneous end-member in terms of crustal formation processes as well as the mixing that must have occurred during the extensive early bombardment history. These data for material associated with large craters, however, indicate that not only is the lunar crust highly heterogeneous across the nearside, but that the compositional stratigraphy of the lunar crust is also nonuniform. If such diversity occurs for even this small planet, crustal complexity should be expected for other planetary bodies to be studied. For maximum compositional information using advanced sensors on future missions (Galileo, MO, LGO) measurement strategy should include high spatial and spectral resolution data in and around large impact craters.