types studied from the lunar sample collection. Although the proportions may not be the same, the returned lunar samples contain components of all the major rock types noted for the near-side crust of the moon with these remote sensing techniques. Within the limited number of areas studied in this project, no areas of a totally unexperienced mineralogy were recognized, although some components of reworked material within craters have not been identified.

It is appropriate to reiterate the relation of existing laboratory near-infrared reflectance measurements of returned highland samples (Figure 3) and these remotely obtained near-infrared spectra of small exposed crustal areas (Figures 6–15). Even though the scale of the measurements made for the laboratory and telescopic data is different by a factor of almost 10^6, both contain compositional information that can be readily identified (orthopyroxenes, clinopyroxenes, Fe-bearing plagioclase, olivine, etc.). On the basis of the characteristic absorption bands for known minerals, distinct rock types have been identified here for surface areas using the telescopic spectra. Specific rock types of the returned lunar samples similarly display a combination of absorption bands characteristic of the minerals present. Two of the most prominent and regular spectral parameters of the telescopic data, continuum slope and strength of absorption bands, are strongly affected by the physical form of the surface material (particle size, size distribution, compaction, etc.) and viewing geometry of the measurement. Since neither of these parameters were controlled in the initial laboratory studies of lunar samples by J. B. Adams, the infrequent correlations, or direct matches, between the sample and the telescopic spectra of similar composition are not surprising. Fortunately, identification of characteristic mineral absorption bands is relatively independent of these physical parameters. In addition to detecting absorption bands, and inferring the presence of specific minerals, absorption strength (sensitive to modal mineralogy) can be measured precisely for the telescopic spectra. A more precise quantification of modal abundances from measured spectral parameters, however, requires more extended and controlled data from laboratory measurements and coordinated analytical techniques that extract abundance information about individual components. Such studies are currently being instigated by a variety of investigators in preparation for anticipated geochemical missions to the moon and planets.

It was unexpected, nevertheless, to find lunar areas a few kilometers in extent that are completely dominated by rock types which often occur only as minor fragments a few centimeters in size in the sample collection (the troctolite, for example, forming Copernicus' three central peaks). The early intense bombardment of the lunar crust and the multiple phases of brecciation frequently observed in the sample collection had suggested the upper lunar crust was well mixed and possibly homogeneous with depth. The mineralogical data presented here for the near-side hemisphere show that this cannot be the case on a lateral nor a vertical scale of tens of kilometers.

Most small areas of freshly exposed crustal material not associated with large craters on the lunar near side exhibit a remarkably similar composition. Three quarters of the small craters and mountains studied (Table 1) are generally noritic in composition with varying degrees of brecciation and secondary matrix (types N-1, N-2, and N-3). If the depth of excavation is estimated to be $\leq\frac{1}{10}$ the crater diameter, these rock types represent the dominant composition of the upper 1 km of the near-side lunar crust. Only about a quarter of the areas studied representing this upper kilometer (Table 1) contain significant gabbroic components and infrequent olivine (types G and O). Thus the upper kilometer of near-side lunar crust appears to be compositionally homogeneous in mafic mineral content to a first order, with type of brecciation and variations in pyroxene abundance being the primary differences between areas, and only pockets of significantly different composition occurring sporadically across the surface. This upper compositional zone corresponds approximately to the megaregolith, a 1- to 2-km brecciated and mixed zone thought to result from the early intense bombardment [e.g., *Aggarwal and Oberbeck*, 1979].

The central peaks of the large craters contain material uplifted from deeper stratigraphic layers, 5 to 10 km in depth (inferred from studies of the central uplifts for terrestrial craters, for example, that of *Grieve et al.* [1981] and *Grieve and Head* [1983]). The variety of rock types observed for central peaks document that the lunar crust is clearly heterogeneous just below the surface kilometer or two of megaregolith. In addition, the central peaks of these lunar near-side craters exhibit a distinctly different distribution of rock types than that observed for the upper kilometer of crust, or megaregolith. Very few of the central peaks studied, only the three group I peaks, are of a noritic composition comparable to that observed for the upper kilometer of lunar crust. The compositions observed for these deeper crustal materials of the central peaks exhibit an array of rock types, many of which are good candidates for outcrops of the more pristine (unmixed, or compositionally unaltered since emplacement) crustal material. The anorthosites (peak group II), the troctolites (peak group III), and the more crystalline gabbros (peak group V) are examples of possible pristine lithologies that occur as mountains tens of kilometers in scale. Numerous fragments of pristine anorthositic and troctolitic compositions have been noticed and studied by persistent lunar sample geochemists [e.g., *Warren and Wasson*, 1980], but they are only very minor components of the sample collection. Although gabbros comparable to peak group V material have not been abundantly recognized in the lunar collection as potential pristine crustal samples, they may represent a significant pristine rock type for the moon.

In order to address additional questions raised by these data, the distribution of these various near-surface rock types must be examined. A sketch map showing the locations of all the areas studied (coordinates listed in Tables 1 and 2) is presented in Figure 16. The locations of major basins are outlined according to their stratigraphic age [*Wilhelms*, 1985; *Whitaker*, 1981; *Wilhelms and McCauley*, 1971]. Although the number of freshly exposed surfaces that can be measured with earth-based telescopes is somewhat limited, the total distribution encompasses many of the major highland areas on the lunar near side. In Figure 17 the distribution of individual rock types has been separated. Areas included in both Table 1 and Table 2 are combined in these figures with the shape of the symbol coded to distinguish small craters from peaks and walls associated with the large craters.

Crustal material of noritic composition (N-1, N-2, N-3, and N-O) is distributed throughout the highlands (Figure 17, top). There is no apparent clustering associated with any basin. Neither does there seem to be any apparent pattern to distinguish the three major different types of noritic material, one of which (N-3) appears to be not as severely brecciated or reworked as the others. If there are physical properties that do indeed distinguish these three near-surface rock types, additional clues will have to be sought in morphological studies