Introduction: In the strictest sense we cannot detect pristine rock with remote techniques: crucial elemental and textural data are lacking. However, criteria can be developed which are analogous to those used for the identification of pristine samples but which draw upon the strengths of remote sensing techniques in an effort to locate areas which are likely to be composed of pristine rock.

This abstract will present a set of criteria for identifying probable pristine outcrops in the highlands using near IR reflectance spectroscopy. Two examples applying these criteria will be presented.

Criteria for Identifying Candidates for Surface Deposits of Pristine Rock: Criteria based on mineralogy and, to a much lesser degree, texture can be developed for use with near-infrared reflectance spectroscopy. New criteria will be defined which draw upon the spatial coverage and resolution of the technique. Finally, criteria will be developed which use the complementary nature of orbital geochemistry and sample data sets to resolve ambiguities using reflectance spectroscopy alone.

The first criterion is detection of an extreme mineralogy, analogous to one of the criteria used for the identification of pristine samples—a "cumulate character" (1). Extreme compositions are those that deviate significantly from the average lunar, mixed mineralogy corresponding to anorthositic norite, i.e., a mixture of plagioclase and low-Ca pyroxene. A spectrum with extreme spectral characteristics would suggest that the area measured had not participated in a high degree of mixing. Monomineralic areas in particular suggest a low degree of mixing. It should be noted that pristine norites (which have mineralogies close to the average of the crust) would not be distinguishable on this basis.

The second criterion is based upon spatial and geologic relationships. If more than one mineral assemblage is detected in a restricted area and a plausible petrological connection can be drawn between these mineralogies, then this would suggest that there exists a differentiated geologic entity which has not been mixed with surrounding material. This criterion is probably only applicable to detection of Mg-suite or other plutons.

The third criterion is a correlation of a measured mineralogy with known pristine rock types. A mineralogy detected which corresponds to that of a pristine rock type will more likely be pristine.

The fourth criterion is the detection of a candidate pristine rock type in a geologic setting which exposes material from depth which may have escaped much of the homogenization attendant with megaregolith formation. A pristine rock is by definition one which has escaped mixing with other rock types by impact. A rock at depth will be likely be better sheltered from mixing than one long exposed at or near the surface. Therefore locations such as central peaks and inner rings of young basins will more likely yield pristine rock outcroppings than near surface geologic settings.

The fifth is coarse grain size similar to Warren and Wasson's criterion number three. This is a fairly difficult measurement, but it is suggested by certain spectral parameters.

The sixth is supporting evidence from other remote sensing data and the lunar sample data.
To summarize the six criteria:

1) Extreme or monomineralic mineral assemblage.
2) Reasonable petrologic connection between mineralogies detected in one location.
3) Correspondence to known pristine rock types.
4) Likely geologic setting (central peaks, basin rings).
5) Coarse grain size.
6) Support from other data sets.

Applications of Remote Criteria:

1) Orientale Basin Example: Certain spectra obtained for the interior of Orientale Basin meet a number of remote pristine criteria. Orientale Inner Rook Mt. spectra represent an extreme composition (monomineralic anorthosite); they correspond to known pristine rock types: anorthosites (ferroan or alkalai); and they are derived from deep within the lunar crust where prior mixing was not likely to have been extensive. These criteria suggest that the Orientale inner ring is composed of pristine anorthosites. The absence of a KREEP component near Orientale (e.g. (2)) indicates that ferroan anorthosites are the pristine rock type present in the Inner Rook Ring of Orientale Basin. Other spectra of Orientale do not suggest the presence of other varieties of pristine rock. The remaining spectra can easily represent well mixed anorthositic norite or noritic anorthosite.

2) Copernicus Example: The presence of abundant olivine was reported in the central peaks of Copernicus (3,4). The spectra of the central peaks all show broad three-lobed absorptions with a combined center beyond 1.00μm. These characteristics are indicative of the presence of olivine. The difference in strength between the "Peak 1" and "Peak 3" spectra have been considered to be due the presence of a neutral absorbing material, most likely plagioclase, at Peak 1 (4). The "Peak 3" location may be less troctolitic or be composed of dunite. Alternatively, the difference may be due to a difference in grain size.

Applying pristine rock criteria to Copernicus spectra, the spectra are compositionally and spectrally extreme. The composition corresponds to known pristine rock types (Mg-suite troctolites, dunite; ferroan troctolites). The central peaks are likely to be composed of material transported from depth. Lastly the strength of the absoprtion of peak 3 spectrum could be an indication of coarse grain size.

Thus a very probable outcropping of pristine troctolite (possibly dunite) occurs in the central peaks of Copernicus. The affinity of this troctolite, ferroan or Mg-rich, is not possible to determine at present.

Conclusion: This abstract demonstrated that candidates for surface deposits of pristine rocks can be identified on the basis of near-IR reflection spectroscopy with support from geologic and orbital geochemistry data bases. Similar analyses of existing data are being undertaken. This approach together with the chemical analyses of orbital geochemistry will allow LRO to effectively inventory the types and abundances of pristine rocks at the lunar surface.