Fig. 6. Reflectance spectra for rock type N-1 (noritic 1) crustal material: (left) spectra scaled to unity at 1.02 μm and offset vertically; (right) residual absorption after a single straight-line continuum has been removed.

are not considered sufficiently accurate beyond 2.2 μm, because of a minor thermal component (see the appendix). The detection of the 2-μm pyroxene band is, however, a key measurement in determination of olivine content: olivine is detected by a broad, multiple band centered slightly longward of 1 μm but has no prominent feature at 2 μm. Iron-bearing glass, which might be present in large-impact melt sheets, has a similar broad band near 1 μm but generally can be distinguished by a lower albedo than olivine-bearing assemblages. The identification of the primary mafic mineralogy of surface material is thus coupled to the detection and analysis of the nature of absorption features near 1 and 2 μm. In the discussion below the terms "noritic," "gabbroic," and "troctolitic" refer to the detected presence of orthopyroxenes, clinopyroxenes, and olivine, respectively.

The abundance of plagioclase, a key parameter in the *Stoffler et al.* [1980] classification of highland rocks, is more difficult to determine with the currently incomplete laboratory spectroscopy calibrations. As was mentioned in section 3, Fe-bearing crystalline plagioclase exhibits a broad weak band near 1.25 μm (Figure 4) and a relatively flat continuum slope. This diagnostic band, however, is easily lost as the result of an impact event or regolith formation. Furthermore, because it is a weak absorption, this band rarely occurs as a well-defined feature. In mixtures with pyroxene the effect of significant amounts of plagioclase ($\geq 50\%$) is to weaken or flatten the reflectance peak between the two pyroxene bands [*Crown and Pieters*, 1985]. Areas of anorthosites 5–10 km in diameter are thus normally identified spectroscopically by a high albedo and the lack of mafic mineral features.

An estimation of mafic mineral abundances comparable to that used for lunar samples classification is possible, but laboratory calibration work with lunar and lunar analog material has only recently been started. Relative mafic mineral abun-

dances can be reliably discussed, and a lower limit to the actual abundances can currently be determined on the basis of mineral mixing experiments for analog lunar soils (D. Crown and C. M. Pieters, unpublished manuscript, 1986). The pyroxene abundances mentioned below are thus underestimated, probably in a regular manner. Until the additional laboratory and modeling work which will provide the desired calibration for lunar mineral abundances is completed, the rock type classification used here for the telescopic spectra is restricted to a somewhat more general scheme than the one used to describe returned lunar samples.

This discussion of highland crustal rock types is based on the analysis of observed spectral absorption features for individual lunar areas. It should be emphasized that the spectal reflectance of each of these lunar areas, however, is not necessarily comparable to the reflectance of individual laboratory samples of the same nominal composition. Although the nature of spectral features for specific mineral assemblages can certainly be easily recognized, the telescopic and laboratory spectra of Figures 6–15 and 3, respectively, are not expected to "match" in the strictest sense because of significant differences in physical characteristics (particle size, distribution of particles, etc.), probable differences in proportions of components in a complex mixed sample, and possible effects from differences in exposure to the lunar surface environment (solar wind and micrometeorites). Furthermore, most of the telescopic spectra are for areas (impact craters and basin massifs) that have undergone substantial shock brecciation. The brecciation alteration effects are only partially understood [e.g., *Adams et al.*, 1979; *Pieters and Horz*, 1985] but are expected to affect the strength and symmetry of absorption features by an effective change in particle size (more interfaces), the disordering of feldspar crystals, and the possible addition of impact melt or a reprocessed absorbing matrix material.