INFRARED SPECTRA OF APOLLO 16 FINES AND COMPOSITION OF PARENT 
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INTRODUCTION: Early balloon-borne observations of lunar mid-infrared 
emission spectra strongly suggested that this spectral range could be used 
to map compositional differences on the lunar surface(1). Subsequent 
laboratory studies of returned lunar soil samples confirmed the validity 
of the remote observations(2).

Unlike those spectral features caused by electronic transitions which 
appear in the visible and near-infrared, mid-infrared features near 10 µm 
are caused by molecular vibrations involving the fundamental structure of 
silicate target materials. Thus, instead of identifying the presence of a 
specific element such as iron or titanium, and suggesting the presence of 
a mineral such as orthopyroxene, mid-infrared spectra provide information 
concerning the bulk composition of the lunar soil. Such information is 
available from lunar surface spectra in the form of two parameters, the 
position and spectral contrast of the mid-infrared emission maxima. The 
effect of varying the environmental conditions on these two parameters 
has been discussed elsewhere(3). For a given environment, such as the lunar 
surface, it can be assumed that differences in these parameters between 
two sites (or surface samples) are caused only by differences in composition. 
Soil composition, in turn, may be affected to some extent by regional 
cross-contamination(4), but is primarily controlled by the composition of 
neighboring parent material.

It is the purpose of this paper to explore the degree of compositional 
heterogeneity in the Apollo 16 landing site area as evidenced by spectra of 
different soil samples, and to determine the significance of cross-
contamination effects on these spectra.

EXPERIMENTAL BACKGROUND: Infrared emission spectra of lunar soil 
samples and terrestrial standards were obtained in a simulated lunar environ-
ment in a manner previously described(2). As described there, the wave-
length position and spectral contrast of the emissivity peaks can be inter-
preted in terms of mineralogy.

We have obtained mid-infrared emission spectra from Apollo 16 soil 
samples from Stations 1, 2, 4, 5, 10 and 11. These spectra are shown in 
Figure 1.

APOLLO 16 RESULTS

The sample collected at Station 11 on the rim of North Ray Crater is 
probably not typical of surrounding soil, being derived at least in part 
from rake disaggregation of an underlying white friable boulder(5). On 
inspection it appears to be composed almost entirely of calcic plagioclase, 
which is consistent with its spectrum in Figure 1. No doubt a good deal
of anorthositic breccia is exposed at the rim of North Ray crater, but it is doubtful that the mineralogy of this sample reflects the average rock composition in the vicinity of its collection. Thus, little can be concluded from this soil spectrum beyond the well-known fact that the Cayley formation contains anorthositic material.

From the astronauts' descriptions, photographs and geomorphological evidence it appears that the soil samples taken from Stations 1, 2 and 10 are mature, typical of surrounding soils and derived primarily from the underlying Cayley formation(5). The spectra of soils collected from Stations 1 and 10 indicate similar mineralogy; a mineralogy that is consistent with that indicated by chemical analyses of other mature soils derived from the Cayley formation(6). In contrast, the soil from Station 2 on the rim of Buster crater, which lies less than a kilometer away from Stations 1 and 10, displays a spectrum which is decidedly different. It has, in fact, an emission maximum characteristic of ultramafic rocks. Thus, if this sample is representative of soil around Buster, this crater may be one source of the rare ultramafic rocks found at the Apollo 16 site(6). Interestingly, Buster is the only crater that the Apollo crew visited that appears to be flat-bottomed, with coarse blocks covering its floor and part of one wall, being a relatively recent crater that penetrated the
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blocky substrate that appears to underlie the regolith at a depth on the order of 10-15 m\(^7\). The source area of the ultramafic parent material of Buster soil is uncertain, but it may be in this blocky layer, or at greater depth.

Our only clues to the composition of the Descartes formation lie in soil samples from Stations 4 and 5, the spectra of which are identical within measurement error. These samples were selected so as to minimize contamination with South Ray crater ejecta, the sample from Station 5 being taken at the bottom of a shallow rake trench. The spectral peaks in emission from these samples lie within approximately 0.1 μ of those found for the soils collected at Station 1 and 10. Thus, with the exception of Station 2, there seems to be no striking difference between the Cayley and Descartes soils, which is in agreement with available chemical analyses of these soils\(^6\). Unfortunately, they have not analyzed the Station 2 soil, and we suggest that such analysis together with a closer inspection of the associated Station 2 rocks should prove very interesting.

Included in Figure 1 is a spectrum of Apollo 11 soil from Mare Tranquillitatis, one of the maria closest to the Apollo 16 landing site. It is clear from a comparison of the Apollo 16 and Apollo 11 spectra that regional cross-contamination has not disguised compositional differences. On a shorter time and distance scale, local cross-contamination in the Apollo 16 landing area has also failed to disguise differences between individual Apollo 16 soil samples.

REFERENCES


