Mössbauer Studies of Apollo 12 Samples

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ABSTRACT

A 44-149 μm fraction of the lunar fines 12042,38 was separated into two fractions with methylene iodide (sp.g.3.3). The light fraction consisted mostly of glass, which frequently was vesicular and semi-opaque and contained micro-breccia fragments and fine metallic iron particles, and plagioclase. The heavy fraction consisted largely of mineral grains with only an occasional glass bead visible. The Mössbauer spectra of the light fraction were very similar to those of the light fraction of Apollo 11 fines 10084,85 suggesting a strong similarity in composition distribution for glasses from the two sites. About 90% of the metallic Fe is associated with the light (glassy) fraction strongly supporting the view that it is of meteoritic origin.

Mössbauer spectra of the heavy fraction showed about 2/3 of the Fe to be present in pyroxene and about 1/3 to be in a phase tentatively identified as olivine with a considerably smaller amount in ilmenite and other constituents. In comparison with the heavy fraction of 10084,85 the abundance of olivine is much greater and that of ilmenite much lower. The high olivine and low ilmenite content of this fraction suggests that olivine rich, ilmenite poor, rocks are predominant in this area.

Mössbauer spectra of unseparated material from four core tube samples (from depths of < 0.5, 5, 19, and 30 cm) do not reveal significant differences from unseparated 12042,38 fines.

Mössbauer studies of synthetic ilmenite samples show that the Néel temperature is lowered about 0.5°K per cation percent excess Fe near the stoichiometric composition. This quantifies our previous assumption that measurements of the

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magnetic transition provide a sensitive measure of the cation stoichiometry. Auxiliary measurements suggest that the electrical conductivity may be a sensitive indicator of oxygen stoichiometry and hence of oxygen activity during formation.

Mössbauer spectra have been obtained on pieces of the three rocks 12063, 12052, and 12038. These rock sample spectra were qualitatively similar to each other and showed the presence of silicates (pyroxene, olivine, and glass) and ilmenite. The ratio of ilmenite-iron to silicate-iron was significantly less for these Apollo 12 rocks than for the Apollo 11 rocks ($\sim$ 0.15 vs. $\sim$ 0.6), and was about a factor of two larger than that for the Apollo 12 dust.

Work is in progress to duplicate both the Mössbauer spectra and microscopic textures in synthetically prepared samples. Spherical smooth walled vesicles and irregular vugs containing projecting crystals generally occur in these synthetic samples. Ulvöspinel overgrowths on chromite cores with distinct boundaries occur in samples prepared at a constant cooling rate. Chromite occurs predominantly enclosed within early silicate phenocrysts. When chromite is completely enclosed in the early silicates no ulvöspinel overgrowths are observed. Chromite in the groundmass has overgrowths of ulvöspinel, with sharp boundaries between the two phases. These relationships indicate that chromite separates early with olivine, while ulvöspinel is late in the paragenesis.

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