Mineralogy of Two Apollo 12 Samples

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Samples 12063, a microgabbro, and 12004, a melanocratic olivine basalt, were studied. 12063 contains evidence of shock metamorphism. The plagioclase, some of which has been melted, is uniform in composition ($\sim An_{90}$) but shows the same cation deficiency as the Apollo 11 feldspar (Weill et. al.,1970). Fayalite + cristobalite are interpreted as resulting from melting of Fe-rich pigeonite, whereas the glass resulted from melting of plagioclase + augite. Some troilite shows undulatory extinction, and ilmenite contains sigmoidally deformed twin lamellae. 12004 possesses none of these features and is relatively unshocked.

The opague minerals (~5% by volume) consist of ilminite (il), FeNi metal, troilite, 4 distinct spinels (sp), and two unidentified phases. In contrast to Apollo 11, troilite and metal commonly do not occur together. Troilite in 12063 contains <0.03% Ni; 0.08% Co; <0.02% Cr; 0.03% Ti (with sp or il, 0.15%). In 12004 it contains <0.03% Ni (with sp + il, 0.10%); 0.12% Co; <0.02% Ti (with sp + il, 0.24%). The metal in 12063 contains

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3.2 - 4.8% Ni; 1.1 - 1.8% Co; 0.06% Ti (with sp or il, 0.14%); <0.03% Cr (with sp, 0.07%).

In 12004 the Ni content of metal depends on its matrix (cf. Reid et al., 1970). In olivine, metal contains 4.1 - 29.7% Ni (1.7 - 3.4% Co; < 0.02 - 0.08% Ti), whereas within other silicates and opaque minerals, it contains 3.5 - 4.6% Ni (1.3 - 1.8% Co; 0.02 - 0.08% Ti, with sp, 0.41% Ti; with sp, 0.42% Cr). The Ni content of the olivines is always low (<0.05%). Equilibrium did not exist between metal particles coexisting within a single olivine grain, as evidenced by large compositional differences; therefore, equilibrium did not exist between metal and olivine. In contrast to metal in Apollo 11, the Ni/Co is always >1 and the Ni content is not due to meteoritic contamination. Ilmenite contains < 2% elemental substitution. Four distinct spinels occur. Those analyzed include: optically isotropic Ti chromites (Ch) (blue, 12063, TiO_2=6.7-9.2, FeO=36.6-39.0, MgO=1.9-3.4, Cr_2O_3=38.3-42.2, Al_2O_3=10.1-11.1, V_2O_3=0.9-1.0, MnO=0.4-0.6%; 12004, TiO_2≃ 4.7, FeO≃30.0, MgO≃4.6, Cr_2O_3≃48.5, Al_2O_3≃11.5, V_2O_3≃1.0, MnO≃0.4%) and two optically anisotropic Cr ulvospinels (U) (brown, 12063,

$TiO_2 \simeq 25.7$, $FeO \simeq 51.0$, $MgO \simeq 1.9$, $Cr_2O_3 \simeq 16.4$, $Al_2O_3 \simeq 4.5$, $V_2O_3 \simeq 0.7$, $MnO \simeq 0.4\%$; pink, 12004, $TiO_2 \simeq 28.3$, $FeO \simeq 55.5$, $MgO \simeq 0.9$, $Cr_2O_3 \simeq 11.0$, $Al_2O_3 \simeq 2.8$, $V_2O_3 \simeq 0.5$, $MnO \simeq 0.4\%$.) The differences in composition between coexisting spinels become very apparent when these values are plotted along the join $FeCr_2O_4$-Fe_2TiO_4 in a $(Fe,Mg)O$-$(Cr,Al)_2O_3$-TiO_2 ternary diagram (cf. Haggerty and Meyer, 1970) and show a compositional void between $Ch_{72}U_{28}$ and $Ch_{36}U_{64}$. The spinels in 12004 show a wider compositional gap than those in 12063.