

## Opaque phases in Apollo 12 samples

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The opaque phases were studied in three samples, namely 12004.50, 12038.67 and 12010.32. In sample 12004.50, which is a fine-grained basaltic rock, Ti-chromite (FeO = 28.4, MgO = 5.72, MnO = 1.32, TiO<sub>2</sub> = 3.96, Cr<sub>2</sub>O<sub>3</sub> = 52.0, Al<sub>2</sub>O<sub>3</sub> = 10.9 → FeO = 33.5, MgO = 2.70, MnO = 0.38, TiO<sub>2</sub> = 4.97, Cr<sub>2</sub>O<sub>3</sub> = 48.9, Al<sub>2</sub>O<sub>3</sub> = 10.9) was the first phase to crystallize. This phase is usually rimmed by Cr-ulvöspinel (FeO = 56.1, MgO = 1.02, MnO = 0.53, CaO = 0.19, TiO<sub>2</sub> = 28.2, Cr<sub>2</sub>O<sub>3</sub> = 8.66, Al<sub>2</sub>O<sub>3</sub> = 2.59) which is occasionally encircled by satellite crystals of cobalt-nickel-iron (Fe = 92.5, Co = 1.27, Ni = 3.99). Olivine, ilmenite (FeO = 46.6, MnO = 0.35, TiO<sub>2</sub> = 51.3, Cr<sub>2</sub>O<sub>3</sub> = 0.30), feldspar and pyroxene crystallized next. Troilite-iron intergrowths are commonly associated with an interstitial glassy phase as immiscible spherical droplets or intergrown with ulvöspinel-ilmenite crystals. The glass phase is sometimes zoned with minute spherules (probably iron) concentrating towards the centre. Modal analysis of this sample (Fe = 0.015, FeS = 0.051, oxides = 2.90) illustrates the reduced amounts of ilmenite present compared with Apollo 11 rocks (14.2). Sample 12038.67 is a coarser grained basaltic rock and has oxide phases similar to those described above but in different relative amounts. Intergrowths of iron in troilite are scarce and troilite occurs either as a homogeneous single phase or intergrown with small crystals of ilmenite which crystallized from the sulphide liquid. Consideration of phase relationships in the system Fe-S-O indicate approximately  $f_{S_2} = 10^{-5}$  and  $f_{O_2} = 10^{-13}$  for the sulphide at 1050°C. Sample 12010.32 is a breccia with shock-induced planar features in ilmenite.