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THE PETROLOGY OF BASALTIC PARTICLES IN THE LUNA 16 SOIL

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Of some 2380 Luna 16 soil particles surveyed, roughly 20% are basaltic. Of those, four in five are primary igneous rocks with nearly holocrystalline ophitic to subophitic texture and with a limited range in grain size (50 to 175 μ). Recrystallized basaltic breccias, very fine-grained devitrified basaltic glasses, and rapidly quenched vitrophyres constitute the remaining 20% of the basaltic particles.

The primary igneous fragments vary from mafic (less than 30% modal plagioclase) to rather feldspar-rich (50% modal feldspar). Textural evidence suggests that plagioclase is the liquidus phase in the felsic group, while olivine, chromite, and pyroxene begin crystallizing before feldspar in the more mafic fragments. The majority of the basaltic particles falls between these extremes, and in them the crystallization of pyroxene and plagioclase seems to have been simultaneous. Late-stage interstitial phases include troilite, native Fe, phosphates, ulvöspinel, zircon, and immiscible K- and Fe-rich glasses.

Luna 16 basalts tend to fall into two groups when their pyroxene compositions are plotted on diagrams showing TiO_2 contents as a function of Fe/(Fe + Mn + Mg) (Figs. 1 and 2). TiO_2 contents in type 1 pyroxenes (Fig. 1) are high in grain cores but fall sharply toward grain boundaries, probably reflecting the removal of TiO_2 from the melt by the simultaneous crystallization of ilmenite. Type 2 pyroxenes (Fig. 2) have lower and less variable TiO_2 contents than type 1 pyroxenes but are more strongly zoned in Fe/Mg and reach more Fe-rich compositions. The more mafic basalts tend to have type 1 pyroxenes, while the more feldspar-rich fragments contain type 2 pyroxenes.

The ilmenites of a given basaltic particle are quite homogeneous with respect to Mg content, although there is variety in Mg/(Mg + Mn + Fe) in ilmenites of different particles. When Mg/(Mg + Mn + Fe) of the ilmenite of a given particle is plotted as a function of the Fe/(Fe + Mn + Mg) ratio of the coexisting pyroxenes (normalized to a constant TiO_2 content) (Fig. 3), some of the basalts ((306-215), (306-77), (306-70)) fall along a well-defined linear trend, suggesting that they may represent successive flows from a differentiating magma chamber. Three type A Apollo 11 basalts plotted on this diagram also fall on a linear trend and may be internally related in a similar fashion. Two Luna 16 particles, (306-241) and (306-236), do not fall on this trend and may be parts of a second flow sequence.

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Basaltic fragments with type 2 pyroxenes may be parts of later flows genetically related to the type 1 fragments or may represent an unrelated, more feldspar-rich magma generation.

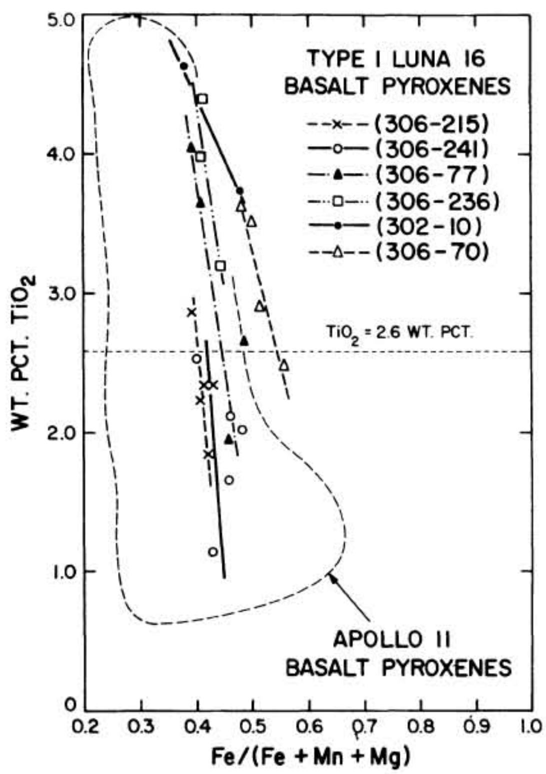

Fig. 1. TiO_2 vs. Fe/(Fe + Mn + Mg) in type 1 Luna 16 basalt pyroxenes.

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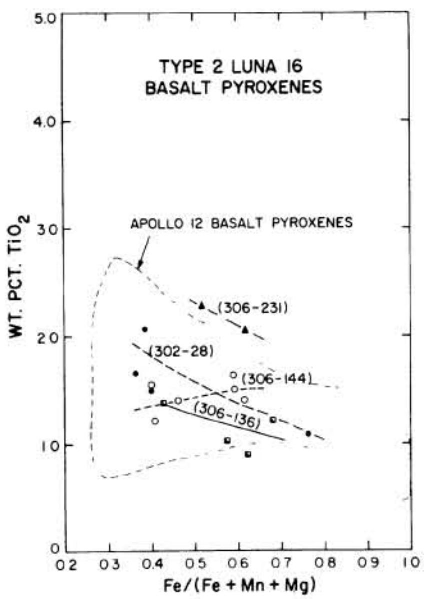

Fig. 2. TiO_2 vs. Fe/(Fe+Mn+Mg) in type 2 Luna 16 basalt pyroxenes.

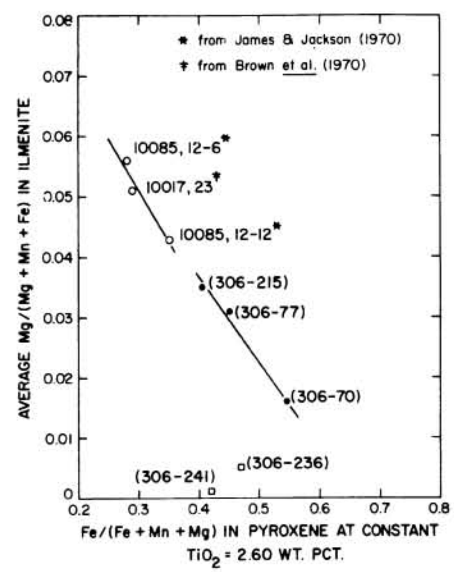

Fig. 3. Average Mg/(Fe+Mn+Mg) in ilmenites as a function of Fe/(Fe+Mn+Mg) in coexisting type 1 pyroxenes having the same concentration of TiO_2 (taken arbitrarily to be 2.60 wt. %).