SHOCK EFFECTS IN LUNAR ROCKS 60015 AND 77017

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Lunar rock 60015 is a white coarse-grained anorthositic rock which is coated with dark-brown vesicular glass. The interior of the anorthositic rock (section 60015,127) consists of highly strained plagioclase set in an intergranular and interstitial matrix of very fine-grained aggregates of plagioclase of the same composition. The intergranular aggregates of plagioclase commonly are arranged in palisade-like structures oriented normal to the margins of contiguous large plagioclase crystals; the interstitial pockets of plagioclase show near-center seams and voids toward which crystallites of plagioclase apparently grew. Although the outer part of the rock appears to be devoid of the fine-grained plagioclase aggregates, a zone of fine-grained plagioclase commonly with palisade structure up to 200-microns in thickness occurs at the contact between the anorthositic rock and the dark glass (section 60015,130). The structure of the fine-grained plagioclase has been interpreted as the result of directional crystallization from a rapidly cooled melt of plagioclase composition (1,2). Such melts may have been produced by shock-induced intergranular melting of either pre-existing anorthosite or, more probably, porous anorthositic breccia derived from the regolith of the lunar highlands.

A microscopic study of rock 60015 in reflected light revealed the presence of a minute quantity of metal particles. The metal grains occur solely in the fine-grained plagioclase aggregates in the form of angular interstitial fillings less than 15 microns in size. Electron probe analysis shows that the metal grains are virtually pure iron which contains 0.20 to 0.25 per cent cobalt and 0.10 to 0.15 per cent nickel. Cobalt is invariably dominant over nickel. The composition of the metal and its Co/Ni ratio are consistent with the hypothesis that the fine-grained aggregates of plagioclase represent a quenched shock-induced melt derived from the large plagioclase crystals by intergranular melting. The metal was probably produced by reduction of iron, cobalt, and nickel ions in the shock-produced liquid of plagioclase composition, and apparently crystallized from the plagioclase melt as a relatively late interstitial phase. Shock-induced reduction of iron ions to metallic iron in the lunar environment has been suggested previously to explain the occurrence of metallic iron in Luna 20 plagioclase (3), subsolidus reduction of ilmenite xenocrysts in shock-produced basaltic glass to iron plus rutile (1), and the abundance of metallic iron in shock-produced basaltic glass (1,4).

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Lunar rock 77017 is a coarse-grained anorthositic gabbro which in section 77017,65 is almost completely surrounded by a thin rind of pale-brown vesicular glass. The gabbro contains olivine which occurs as euhedral to subhedral crystals surrounded by single-crystal mantles of pyroxene and as relatively small round grains enclosed in plagioclase. The pyroxene occurs as large poikilitic plates which enclose euhedral to subhedral plagioclase and which are commonly in optical continuity with the pyroxene mantles of the olivine. The pyroxene is pigeonite which contains coarse exsolution lamellae of augite parallel to (001). The rock also contains a relatively large amount of metal (perhaps one or two per cent by weight) which is commonly associated with troilite. The metal occurs as very large irregular grains up to 300 microns in size which form void-free interstitial fillings between the silicate grains. The textural relationships suggest that it is a late-magmatic constituent. The composition of the metal as determined by electron probe analysis is 87-95 per cent iron, 7-13 per cent nickel, and 0.5-1.0 per cent cobalt. The gabbro appears to have been shocked as based on undulatory extinction and mosaicism of the plagioclase and the very intense fracturing of the plagioclase. In addition, the rock contains narrow zones of relatively fine-grained crushed material of the same mineral composition as the main body of coarse-grained rock. There is no textural evidence for movement or transport of the comminuted material of the kind which is characteristic of cataclastic tectonites and the crushed zones are considered to be produced by shock. A detailed study of the microstructure of the metal in this rock is in progress inasmuch as the inferred shock history of the rock should be recorded in the metal.

There are about six reported occurrences of a regular micro-intergrowth of K-feldspar and quartz in the returned lunar samples. One of the largest occurs as a clast about one square mm in diameter in glassy-matrix breccia 12057,22 (5). Such granitic material is of considerable importance in the development of petrogenetic models of lunar evolution. Accordingly, in collaboration with M. Prinz and K. Keil, an electron microprobe study of the phase chemistry of the granitic clast in 12057,22 has been completed, and the petrological implications of the results are under consideration.

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