Metallic Iron in Lunar Sample 79002,2030

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Introduction: The reduction of iron in lunar regolith glasses has been suggested as a means of producing oxygen on a lunar base. Experiments on Apollo 11 simulants have shown that oxygen is released during iron reduction under controlled conditions [1,2]. However, lunar conditions have yet to be simulated. The feasibility of oxygen production by reduction at lunar conditions could be considered by studying the metallic iron grains found on glass spherules in the lunar regolith. Comparing the lunar iron grains to similar grains that have been produced in lunar simulants by reduction processes [3] shows that reduction does occur on the moon [4].

Results: Sample 79002,2030 a hollow glass spherule from Apollo 17 soil, was broken for analysis and studied, using the SEM and X-ray dispersion. The most common feature of this ball is a lacy structure of connected iron grains (Fig. A), found both on the interior and exterior surface of the grains, though much more common on the exterior. Also prevalent are more massive formations (Fig. B), where large grains of iron are surrounded and joined by interstitial iron sulfide (troilite). The centre left edge of Fig. A shows a region where the lacy and massive iron are merging. Quite rare, but nevertheless occurring on both exterior and interior surfaces, are mounds of iron-troilite (Fig. C). Thin sections of this sample were also prepared and studied. In the interior, iron is present mostly in small grains giving the glass a speckled appearance (Fig. D). Larger configurations are also found, but these are very rare. Generally, large concentrations of iron occur on the surface or in vesicles. Troilite is also found in the interior as small speckles, difficult to distinguish by appearance from metallic iron.

Discussion: Many of the features identified, at first glance appear to be splatter or splash formations. Their presence on both the interior and exterior surfaces, as well as on vesicle walls, contradicts that possibility.

Vapour condensation has also been proposed as a method of formation [5]. If iron sulfide vapour were trapped in the molten glass, the cooling gas would naturally deposit crystals on vesicle walls. There are two problems with this hypothesis. The smaller vesicles could not possibly contain enough iron in a vapour phase to deposit the amount of iron observed. Also, this method would not account for the speckles of iron seen in the interior of the glass. Vapour condensation could not have played a major role in lunar iron formation.

Laboratory reduction of simulated lunar glasses, however, has produced features analogous to those seen on the lunar sample. The lacy iron of Fig. A bears a remarkable resemblance to some simulated iron [3 fig 15,25]. Features similar to the massive iron of Fig. B are also found, where it is shown that iron sulfide forms "waists" around iron grains [3 fig. 20,24]. Grains comparable in size to Fig. C have also formed [3 fig. 21, 2 fig 2]. Therefore reduction processes are capable of producing all of the surface features found on lunar spherules.

The most likely method of formation for the lunar iron grains is therefore by reduction, showing that reduction can occur naturally on the lunar surface. Thus, reduction could conceivably be a method for oxygen production on the lunar surface. However, further studies involving actual reduction of lunar glasses at lunar conditions should be conducted before any such claim could be made.

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