ORIGIN OF A 6 MM GLASS SPHERE FROM THE APENNINE FRONT: DEBRIS IN THE RIND. Graham Ryder, Lunar and Planetary Institute, 3303 NASA Rd. 1, Houston, TX 77058.

15434,28 is a 0.39 g, 6 mm diameter sphere collected on the Apennine Front, Apollo 15. It consists of a yellow/orange glass of intermediate-Ti composition (TiO_2 3.4%), distinct from both the Apollo 15 yellow volcanic and impact glasses. Its interior is homogeneous and crystal-free, but the exterior is a thin diffuse rind (less than 200 microns thick) containing debris of mare basalt materials. The glass and its major and trace element chemistry were described by Ryder [1,2] who concluded that it was an exceptional volcanic glass (large size, adhering rind, evolved chemical composition). If it is an impact glass it is no less remarkable (homogeneity, lack of vesicles, apparent lack of meteoritic contamination). Here I report the characteristics of the materials in the rind, indicators of the geological and petrological context of the glass sphere.

The exterior surface is dull, dark gray, and slightly bumpy or blistered, with scattered mineral and lithic fragments embedded in it. The fragments have clean surfaces, lacking adhering dust or glass. The largest visible macroscopically is a 2 mm coarse mare basalt that protrudes out of the rind. The mineral fragments are mainly olivines and pyroxenes, with some plagioclases.

One thin section (,130) was cut tangential and close to the surface of the sphere, so that it grossly over-represents the rind material (Fig. 1); a serial section (,131) is more interior and contains much less debris. The rind shows crystallization around clasts, with dendritic olivines (Fig. 1). Apart from olivines, pyroxenes, and plagioclases, the sections contain some spinel and chromite, some small mare basalt pieces, and a few tiny devitrified brown spherules. The fragments are fairly angular and have not noticeably reacted with the glass. Microprobe analyses show that the phases are those of low-Ti/intermediate-Ti mare basalts (Figs. 2-5). The pyroxenes have zoning and minor element abundances (Figs. 2, 3) identical with those in the local olivine-normative mare basalts, and quite different from those of high-Ti or very low-Ti basalts. Furthermore, the trends are those of slower-cooled olivine-normative mare basalts. The olivines show the high CaO (more than 0.2%) and the plagioclases the high FeO (more than 0.3%) typical of lunar mare basalts (Figs. 4, 5), and both have ranges of compositions consistent with coarse-grained local olivine-normative basalts. The spinel (ulvospinel) and ilmenite compositions are consistent with mare derivation. Four small devitrified spheres analyzed have the compositions of Apollo 15 volcanic green glass. On the basis of Mg/Si, Al/Mg, Mg/Fe, and CaO abundances, two of them are group A and two are group D, the most common compositions found among Apollo 15 samples [3,4].

Fig. 1: Thin section of 15434,130. Plane light, field of view about 2 mm across.

6 MM GLASS SPHERE: Ryder G.

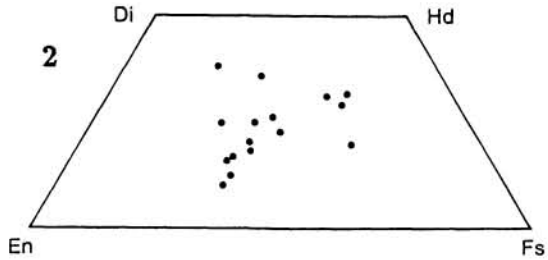
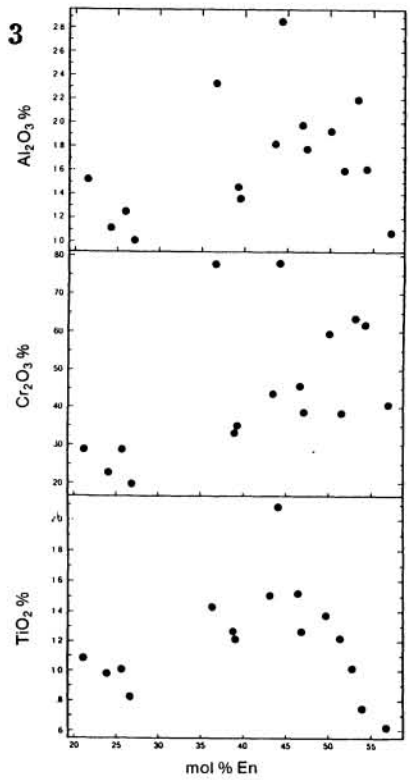
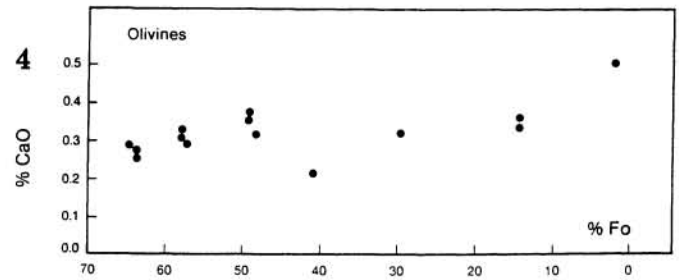
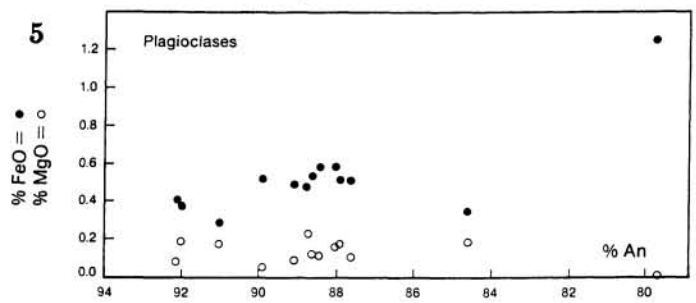


Fig. 2: Pyroxene quadrilateral for 15434,130 rind clasts.
Fig. 3: Minor elements in pyroxenes in rind in 15434,130.
Fig. 4: CaO v. Fo for olivines in rind in 15434,130
Fig. 5: FeO and MgO v. An for plagioclases in rind in 15434,130.







References [1] Ryder G. (1990) Workshop on Apollo 14, LPI Tech. Rept., in press. [2] Ryder G. (1989) Catalog of Apollo 15 Coarse Fines. JSC #24035. [3] Delano J. (1979), PLPSC 10, 275. [4] Ryder G. (1986) LPS XVII, 738. [5] Ryder G. (1988) PLPSC 19, 43. [6] Whitford-Stark J. (1980) LPS XI, 1245.

The phases present in the rind of 15434,28 are all derived from olivine-normative mare basalts and (very minor) volcanic green glass such as occur at the landing site itself. Quartz-normative basalts could be represented in the debris, because their mineralogy differs little from that of the olivine-normative basalts apart from their lack of olivine. However, no KREEP basalt or feldspathic crustal material is present, nor yellow volcanic or impact glass. The sharp contrast between the homogeneous, crystal-free glass itself and the coarse mare fragments suggests that there was no close relationship of the glass and the crystals, and the pyroxenes probably contain too little TiO_2 to be related to the glass. The glass, whether volcanic or impact, must be at least slightly younger than the Apollo 15 olivine-normative basalts, which are probably the youngest volcanic rocks at the site [5]. The basalts in Palus Putridinis do not extend far from the landing site [6], so presumably 15434,28 is of local origin. It must have cooled extremely fast: its composition is such that it is at the limit of being able to form a glass sphere so large (J. Delano, pers. comm.). The materials in the rind were picked up during flight, otherwise they would be evenly distributed through the glass (if collected at the immediately at the source eruption or impact), or covered in regolith dust (if stuck on after landing). An impact glass would be expected to entrain debris from the target rock itself, and that is patently not the case for 15434,28, thus suggesting a volcanic origin. Further work on the rare gases (age, solar wind components) of both rind fragments and interior glass to elucidate the origin of this exceptional glass sphere is planned.