ORIGIN OF ORANGE GLASS SPHERULES IN APOLLO-17 SAMPLE 74220
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Three mechanisms proposed for the origin of this orange soil (and for similar aggregations from other lunar sites) are: I) vapor condensation; II) volcanic fire fountaining; and III) meteorite impact on solid lunar crust. We believe that each of these is precluded for the orange soil by one or more lines of evidence; hence, we have proposed a fourth origin, IV) meteorite impact on liquid lava containing olivine phenocrysts.

Our sample consists of grains almost 100% <0.3mm that are ~99 percent smooth shiny spherules (or broken fragments) of transparent orange glass and the opaque partly crystallized equivalent of the orange glass. This material came from a much larger volume of orange soil in the outcrop, but all orange glass in our sample has an extremely uniform index of refraction (~1.712). In contrast, other lunar sample spherules range from 1.50 to 1.75. The orange glass is also completely free of bubbles to the limit of resolution of the light microscope, whereas bubbles are present in many other spherule samples. The color varies with thickness from yellow-orange to red-brown. The spherules appear spherical, but many, even as small as 40μm, are oblate spheroids with axial ratios as low as 0.42 (Fig. 1). Some have fissioned during free flight, as those described from Apollo-11 soils.
Although many have been chipped or broken since solidification, only a few appear to have landed while still soft. One notable exception is the occurrence of small spheres of orange glass conforming and adhering to the surface of larger black spheres; presumably this collision occurred during liquidus because of relatively small differences in individual velocities or trajectories. Where free of crystals, the orange glass is remarkably uniform in composition within particles (Fig. 2b) and one particle to another. Table 1 gives the average of 12 individual spherule analyses; the major elements do not vary outside the precision of any individual analysis—1 to 5 percent of the total present. The composition is that of an ilmenite-olivine ma...