LIBYAN DESERT GLASS: REMNANTS OF AN IMPACT MELT SHEET;
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Libyan Desert glass (LDG), a natural glass with a composition of about 98 percent silicon dioxide, is found only in the Libyan Desert in southwestern Egypt. Formed about 28.5 million years ago, it has been an active subject for research since its discovery by P. A. Clayton in 1932.

LDG has often been associated with tektites. This association and the aerodynamically ablated form of many tektites has apparently influenced some investigators to at least infer that LDG has also undergone ballistic flight (O'Keefe, 1976). This would mandate that LDG, if created on earth by impact of an extraterrestrial object, be of ejecta origin. Impact events and ejecta acceleration times are generally considered to be of short duration, a fact difficult to reconcile with the processes of glass-making (O'Keefe, 1976). By this line of reasoning, then, LDG cannot be impact ejecta. This is in agreement with the observation that, to date, no piece of LDG exhibiting evidence of atmospheric travel has been analyzed (Weeks, et al., 1983).

The contrary position, that LDG and similar glasses with high silica content are not true tektites, has been advanced by Baker (1963) and others. Removal of the tektite label permits considerably greater flexibility in the search for the mechanism for formation of LDG by relaxing the constraint of related origins for the tektites and the tektite-like glasses (including LDG). For example, Glass (1981) advances the position that LDG was probably formed by impact melting of sand or sandstone.

We support the viewpoint that LDG is impact glass and reject the proposition that the formation processes of LDG and tektites must be related. We do not subscribe to the inference that the only possible impact formation theory invokes ejection of the glass from the crater. Instead, we submit that the glass fragments now observed on the desert surface are remnants of a continuous melt sheet produced by impact in sand or sandstone. The melt sheet formed along the transient crater floor during the cratering process, was covered by target material, and cooled at the proper rate to form glass. The glass remained covered, perhaps for several million years, until erosional processes removed the upper strata of the crater, uncovered the glass, undermined and fragmented the melt sheet, and dispersed the glass fragments over a region substantially greater in length and width than the crater diameter.

Comparisons of some of the characteristics of LDG with those of impact melt rocks in known impact structures support the melt sheet model. Melt sheets have very uniform compositions closely approximating the average compositions of the target rocks (Grieve, et al., 1977). LDG specimens exhibit very little variation in composition both within specimens and from one specimen to another, and the composition of the glass is very similar to that of the surficial sand and some of the sandstone outcrops presently in the glass area (Weeks, et al., 1983). Impact melts in lens or sheet form exhibit schlieren indicative of shear flow while heated. LDG contains ample evidence of shear flow, both as striae and elongated gas bubbles within individual specimens. Comparisons with known impact glasses are also instructive. The glass from the Aouelloul crater is in small, irregular fragments that are full of bubbles (Glass, 1981). This crater is much...
smaller than craters with observed continuous impact lenses or melt sheets, indicating that the impact energy for the Aouelloul crater was simply too low to produce a continuous mass of melt.

The melt sheet model for the formation of LDG meets the objections of O'Keefe (1976) concerning the glass-making process. Following Grieve, et al. (1977), this sequence is suggested: The melt is produced by the process of shock heating and subsequent pressure release. The molten mass then flows outward from the impact center along the transient crater cavity, possibly incorporating less shocked and unshocked target material. The interior of the melt sheet remains at high temperature, and thus at low viscosity, for sufficient time for bubbles to rise out of a substantial portion of the melt. The entire mass, which is covered by colder target material, then cools at the rate required to produce silica glass. Some bubbles are trapped as the viscosity increases rapidly in the cooler portions of the melt sheet.

The larger LDG specimens exhibit results of wind erosion and dissolution by water, and no samples represent an edge of an originally larger mass of glass or contain less shocked or unshocked parent material as inclusions (Weeks, et al., 1983). An coesite or stishovite formed would have been digested into the melt, or removed by dissolution or erosion. The original edges of the melt, where unshocked sand grains would be expected, would have also been removed by dissolution and erosion. No meteorite signatures have been identified in LDG (Weeks, et al., 1983). This is not unexpected for any given impact crater, since only a small fraction of the total number of identified impact craters have associated meteorite fragments (all small diameter craters without melt lenses or sheets) or other meteoritic signatures (Grieve, 1982). No crater or evidence of shock metamorphism has yet been found less than 150 km from the glass area. It is apparent that most or all traces of a crater have eroded away or are under the surficial material awaiting discovery.


