same as that of the interviral product before hemadsorption, except that in some experiments it showed a shift toward the density of the influenza virus. The photographic records of our experiments indicate that this shift in density occurred when the incubated viral mixture contained some excess influenza virus which was hemadsorbed along with the interviral product. We therefore consider that the original interviral product and the excess influenza virus may have further reacted after elution to yield a final product of higher density.
4. R. Markham, *Advan. Virus Res.* **9**, 252 (1963).
5. W. A. Stenback and D. P. Durand, *Virology* **20**, 545 (1963); L. V. Crawford, *ibid* **12**, 143 (1960).
6. F. Sokol, *ibid.* **21**, 126 (1963).
7. G. K. Hirst, *Cold Spring Harbor Symp. Quant. Biol.* **27**, 305 (1962); A. Granoff, *ibid.* **27**, 319 (1962).
8. L. Hoyle, *ibid.* **27**, 113 (1962).
9. In collaboration with G. de The.
10. We thank R. A. Bredland for preparing the photographs and E. Sheets, Miss Helen Engelbrecht, and Mrs. Ida Gaines for laboratory assistance. Supported in part by National Cancer Institute special fellowship 5-F3-CA-13741-03, USPHS.

17 August 1964

Spalled, Aerodynamically Modified Moldavite from Slavice, Moravia, Czechoslovakia

Abstract. *A Czechoslovakian tektite or moldavite shows clear, indirect evidence of aerodynamic ablation. This large tektite has the shape of a teardrop, with a strongly convex, deeply corroded, but clearly identifiable front and a plano-convex, relatively smooth, posterior surface. In spite of much erosion and corrosion, demarcation of the posterior and the anterior part of the specimen (the keel) is clearly preserved locally. This specimen provides the first tangible evidence that moldavites entered the atmosphere cold, probably at a velocity exceeding 5 kilometers per second; the result was selective heating of the anterior face and perhaps ablation during the second melting. This provides evidence of the extraterrestial origin of moldavites.*

In Bohemia and Moravia during March and April of 1964, I inspected over 15,000 moldavite specimens. My main purpose was to uncover moldavites showing evidence of aerodynamic ablation or containing various inclusions. Most specimens are in the National Museum in Prague; many are in the private collections of Jan Oswald of Český Budějovice (3500) and Josif Prokopec of Český Krumlov (500). A few of the moldavites inspected belong to Charles University and other private collectors. Most of the specimens are fragments, mostly platy and some subrounded. Many are of teardrop shape. A few are rod- or disc-shaped; a few are curved plates. Dumbbell-shaped and core-shaped moldavites are rare, but do occur. A striking feature of the assortment and frequency of shapes of the moldavites is their similarity to those of Thailand and Indochina.

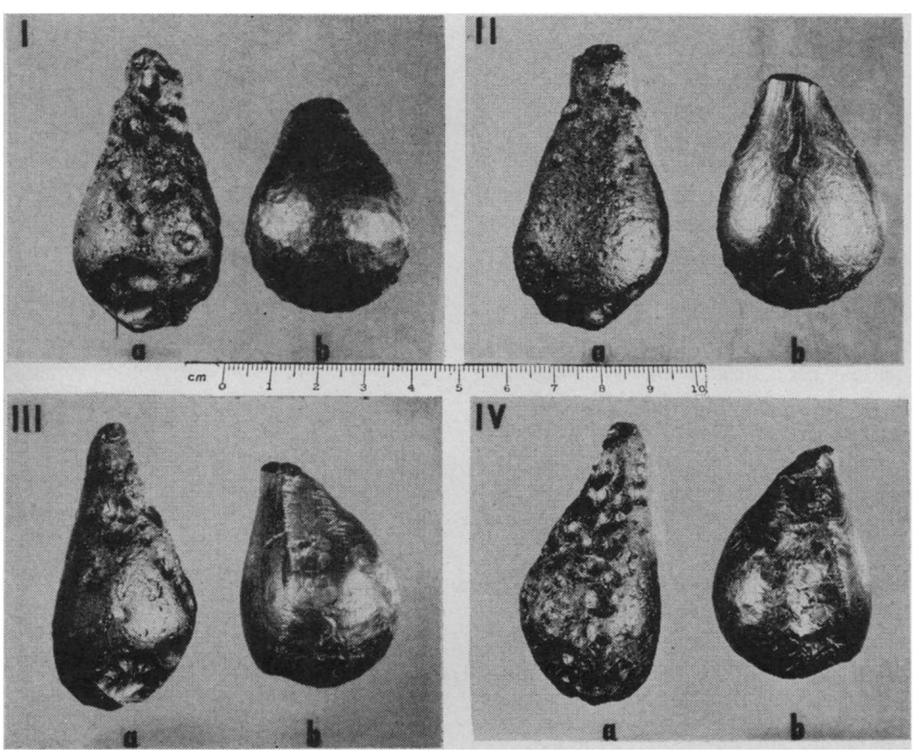

Fig. 1. Comparison of a spalled moldavite teardrop from Slavice (*a*) with a spalled australite teardrop from Renmark, South Australia (*b*). I, Anterior view; II, posterior view; III, side view, with posterior side to the left; IV, side view, with posterior to the right.

Of the many specimens inspected, the specimen described herein is the only one showing indirect evidence of aerodynamic ablation. It is a large, teardrop-shaped moldavite collected by Jaromir Šofr of Třebíč from a plowed field in an area of moldavite-bearing gravel adjoining the west side of the village of Slavice in Moravia. It is greenish brown in color and translucent. It is 67 mm long, 33 mm wide, and 30 mm thick at the maximum cross section, perpendicular to the long axis; it weighs 64.75 g. Except near the tip of the teardrop which is slightly chipped in two places, the gross teardrop shape is well preserved.

The profile is best observed with the specimen lying on its side (Fig. 1, *a* in parts III and IV). The highly convex anterior side (Fig. 1, *a* in parts I, III, and IV) is covered with deep or shallow pits of corrosion origin. The local flow structure or schlieren is revealed in and across the pits. The plano-convex posterior side is relatively smooth and well preserved (Fig. 1, *a* in part II), in spite of local crescent-shaped percussion marks indicating erosion during transport in running water. The break in the curvature between the plano-convex posterior and the strongly convex anterior portion (the keel) is evident and locally well preserved (Fig. 1, *a* in part III); elsewhere the keel is not so sharply defined.

An ablated and spalled large australite teardrop is shown for comparison (Fig. 1*b*). With australites, flaked cores, boats, dumbbells, and flanged buttons show various stages of spalling as represented by specimens which partially retain the ablated front and side surfaces; these are known as "indicators" (*1, 2*). Figure 2*a* shows an indicator of an australite button with most of the anterior portion spalled off. The ring waves on the remnant unspalled piece make it clear that spalling of the aerothermal stress shell did

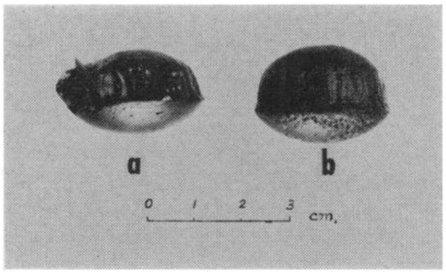

Fig. 2. The partially spalled "indicator" core of an australite (*a*) from Charlotte Waters, Northern Territory, Australia. Ring waves on the remnant unspalled portion are clearly visible. A spalled core with the aerothermal shell completely removed is shown on the right (*b*), from Hampton Hills, Kalgoorlie, Western Australia.

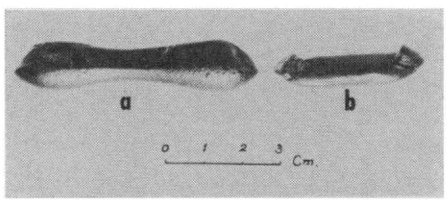

Fig. 3. (*a*) A spalled dumbbell with the aerothermal shell completely removed, and (*b*) an "indicator" dumbbell with remnant aerothermal stress shell. Both from Hampton Hills.

take place. Complete spalling of this aerothermal stress shell, formed by secondary reheating and aerodynamic ablation, results in a core as shown in Fig. 2*b*. Similarly, an indicator of a partly spalled dumbbell (Fig. 3*b*) shows how a spalled dumbbell-shaped australite (Fig. 3*a*) was derived. The spalled australite teardrop (Fig. 1*b*) and the spalled moldavite (Fig. 1*a*) are similarly derived, both having a history of aerodynamic heating and ablation.

Formation of a core as a result of the spalling off of the aerothermal stress layer of the anterior and girdle areas of ablated australites and other Australasian tektite specimens has been experimentally demonstrated by Chapman (*3*), using artificially ablated specimens of tektite glass. There is no uncertainty concerning the derivation of these spalled tektites, although evidence of primary aerodynamic ablation has been completely removed.

Suess (*4*) described in detail the sculpture of moldavites and interpreted the various highly polished intricate patterns of surface pits and grooves as being of aerodynamic origin. Although the detailed mode of formation of such sculptures is not well known in all cases, I have observed identical sculptures in philippinites, indochinites, and Thailand tektites where the sculptures were formed subsequent to rounding of the specimen by transport in terrestrial bodies of waters. The similar intricate sculpture on moldavites which I have examined also has a late history—that is, the sculpture was formed after the moldavites landed on Earth. It is considered to be of corrosion origin, in agreement with the independent study of Rost (*5*).

The large, teardrop-shaped moldavite provides the first tangible evidence that moldavites also suffered aerodynamic heating of the anterior face, and perhaps ablation, during a second melting on entry into Earth's atmosphere. The moldavite must have entered the atmosphere as a cold glass body, probably at velocities greater than 5 km/sec; no ablation occurs when tektites enter at less than 5 km/sec (*6*).

Chapman and Larson (*6*, p. 4340) discussed in detail the difficulty involved for terrestrial impact as an origin of tektites from the point of view of aerodynamics, and pointed out that, for molten blobs of fused earth to fly through the atmosphere unmolested by aerodynamic forces at exit angles as shallow as 12 degrees, a relatively high vacuum of less than 2×10^{-7} atm must exist over an area of 500 km radius. The moldavite from Slavice was aerodynamically heated and perhaps ablated, requiring the presence of atmosphere over the Bohemian and Moravian tektite-strewn field which is less than 400 km from the Ries crater of southern Germany. This is strong indication that moldavites could not have derived from the Ries. This conclusion agrees with the chemical evidence that moldavites are not related to Ries glass or to the Ries crater (*7*, p. 90).

This report is intended not only to record evidence favoring the cosmic origin of moldavites, but also to call attention to the need for finding better-preserved moldavites that will provide more useful aerodynamic information regarding their place of origin.

E. C. T. CHAO

U.S. Geological Survey, Washington 25, D.C.

References and Notes

1. C. Fenner, *Trans. Roy. Soc. S. Australia* **59**, 125 (1935).
2. G. Baker, *Mem. Natl. Museum Victoria* **23**, (1959).
3. D. R. Chapman, *Geochim. Cosmochim. Acta* **28**, 841 (1964).
4. F. E. Suess, *Jahrb. Geol. Reichsanstalt Wien* **50**, 193 (1900).
5. R. Rost, verbal communication (1964).
6. D. R. Chapman and H. K. Larson, *J. Geophys. Res.* **68**, 4305 (1963).
7. E. C. T. Chao, in *Tektites*, J. A. O'Keefe, Ed. (Univ. of Chicago Press, Chicago, 1963), pp. 51–94.
8. I am grateful to D. R. Chapman and H. K. Larson of Ames Research Center, NASA, Moffett Field, Calif., for use of casts of the australite indicator button and the large spalled teardrop, and to Carleton Moore for the loan of australites obtained by H. H. Nininger from Hampton Hills, Kalgoorlie, Australia. I particularly thank Vladimír Bouška of Charles University, Prague, who planned and guided my field trips to the Bohemian and Moravian basins, and Jaromír Šofr of Třebíč for contributing the moldavite teardrop described.

31 August 1964

β-Galactosidase: Inactivation of Its Messenger RNA by Ultraviolet Irradiation

Abstract. *A brief exposure of* Escherichia coli *cells to an inducer for β-galactosidase results in the production of a messenger RNA which subsequently expresses itself as β-galactosidase. Ultraviolet irradiation of cells after exposure to the inducer results in a decrease in the amount of β-galactosidase formed. The messenger RNA formed during the brief exposure to inducer is evidently inactivated by the ultraviolet radiation. The decay of messenger RNA activity in irradiated cells has the same kinetics as that observed in unirradiated cells.*

Ultraviolet irradiation prevents the formation of induced enzymes in yeast (*1*) and *Escherichia coli* (*2*). The spectra of the active substances for the inhibition of both systems have maxima at 2600 Å (*2, 3*). This result suggests that nucleic acids are damaged by ultraviolet irradiation but does not distinguish between DNA and RNA as the affected compound. We have taken advantage of the fact that *E. coli* cells, exposed briefly to an inducer for β-galactosidase, form messenger RNA (mRNA) that functions even after the inducer is withdrawn (*4, 5*). Measurements of β-galactosidase activity in cells irradiated after the inducer is withdrawn, but before mRNA has decayed, yield evidence that mRNA is inactivated by ultraviolet radiation.

The action of ultraviolet radiation on cells that had been exposed to inducer was studied by the method described by Kepes (*4*). The general plan of the experiment—with its interpretation of the attendant molecular events —is shown in Fig. 1. During the 20-second exposure to inducer isopropyl-