LETTERS TO THE EDITORS

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Origin of Tektites

IN a recent communication[1], Dr. Kohman suggests that tektites are meteorites which originate in interstellar space and collide with the solar system. I should like to direct attention again to the various facts that must be explained by any acceptable postulated history of these objects. (1) Tektites have chemical compositions remarkably similar to those of the more acid sedimentary rocks. This is true for the major and minor constituents. (I have been privileged to see analyses as yet unpublished on these minor constituents.) Such a chemical composition is not produced by any other naturally occurring chemical processes that we know of, except perhaps in very rare and special circumstances. (2) Tektites obviously have been melted, and this means that a temperature of some 1,500° C. or more was supplied by some means. In fact some appear to have been reheated to the melting point by passage through gas or by a blast of gas over the object. No terrestrial source of heat is known which could produce such high temperatures. (3) They are distributed thinly over areas of hundreds and thousands of kilometres in linear dimensions. (4) They are reported to contain aluminium-26 and beryllium-10. This observation is due to Dr. Kohman and Dr. Ehmann.

Dr. Kohman ignores items (1) and (2) above and gives us not the slightest indication as to how these objects could have accumulated, acquired their chemical composition and become melted in interstellar space. Apparently the problems that have concerned geochemists when a terrestrial origin is assumed become completely inconsequential when they are referred to the great cold vacuum far from the Sun. However, if items (1), (2) and (3) above could have been explained by non-miraculous means, neither Dr. Kohman, I, nor most of the readers of *Nature* would ever have heard of tektites.

Again I wish to direct attention to a suggestion I made last year[2], namely, that comet heads occasionally collide with the Earth, that such collisions would result in a flame-like mass of gas at a very high temperature capable of volatilizing the comet head and melting surface rocks of the Earth, and that high pressures capable of scattering bits of melted terrestrial materials over large areas would be developed. This was advanced in order to explain items (1), (2) and (3) above. The data of item (4) were not available at the time. It should be noted that Kohman and Ehmann's data required the lowest level counting technique that has been attempted and hence might well be checked by others, and that the terrestrial rocks used for comparison came from the glaciated area of Canada and an obsidian cliff in California, and hence they could scarcely have accumulated aluminium-26 and beryllium-10 from cosmic sources. Also, it may be that these elements could have been supplied from constituents of the comet head, though I am not particularly fond of this suggestion.

But comet heads should collide with the Earth from time to time. What effects should they produce? Would not something resembling the Alamagardo glass of the atomic bomb explosion be produced possibly or even probably? The energy of collision of a comet head with the Earth can reasonably be estimated as equivalent to some million or more atom bombs.

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[1] Kohman, T. P., *Nature*, **182**, 252 (1958).
[2] Urey, H. C., *Nature*, **179**, 556 (1957).

Number of Elastic Constants required in Crystal Elasticity

IN recent years there have been several publications by Laval[1], LeCorre[2] and other authors[3–5] suggesting a more general approach to crystal elasticity, which, among other features, requires for a triclinic crystal 45 independent elastic constants instead of the classical 21 (with corresponding increases in each of the crystal classes). The stress tensor is not symmetrical, and body couples (or volume couples) act in the crystal.

We show in this communication that in those cases in which the Laval–LeCorre theory is applicable the number of independent elastic constants actually is 39 and not 45. This reduction is brought about by means of energy considerations and the following hypothesis.

Given a crystal subject to mechanical strains only, a necessary condition for the appearance of body couples in a certain element of volume is that a deformation should be present. (It is not stated that this condition is sufficient.)

In the strain–energy function

$$W = \tfrac{1}{2}\sum_{i,j=1}^{9} c_{ij}\varepsilon_i\varepsilon_j \qquad (1)$$

the following substitutions are introduced:

$$\left.\begin{aligned} \varepsilon_4 &= \varepsilon_{23} = \varphi_1 - \theta_1 \\ \varepsilon_7 &= \varepsilon_{32} = \varphi_1 + \theta_1 \\ \varepsilon_5 &= \varepsilon_{31} = \varphi_2 - \theta_2 \\ \varepsilon_8 &= \varepsilon_{13} = \varphi_2 + \theta_2 \\ \varepsilon_6 &= \varepsilon_{12} = \varphi_3 - \theta_3 \\ \varepsilon_9 &= \varepsilon_{21} = \varphi_3 + \theta_3 \end{aligned}\right\} \qquad (2)$$

The meaning of the new variables is the following: $2\varphi_\alpha$ is the pure shear deformation $\left(\frac{\partial u_\gamma}{\partial x_\beta} + \frac{\partial u_\beta}{\partial x_\gamma}\right)$ and θ_α is the pure rotation $\frac{1}{2}\left(\frac{\partial u_\gamma}{\partial x_\beta} - \frac{\partial u_\beta}{\partial x_\gamma}\right)$ around an axis parallel to X_α in every element of volume. If these new variables are introduced into equation (1), the energy density W becomes a function of the ε_α, φ_α and θ_α ($\alpha = 1, 2, 3$), and it can be separated into three parts:

$$W = W_d + W_{dr} + W_r \qquad (3)$$

W_d has terms that contain pure deformations only (ε_α and φ_α); W_r has terms that contain pure rotations only (θ_α); the terms of W_{dr} contain both deformations and rotations.

The strains ε_i ($i = 1, 2, \ldots 9$) and all the other elastic variables are functions of position and time; but consider a point in which at a given instant the strains are such that no pure deformation is present, that is, ε_1, ε_2, ε_3, φ_1, φ_2 and φ_3 all vanish. When