Table 2 Ages of Geologic Periods and of Tektites

Geologic period	Ages[8] (m.y.)	Ages[9] (m.y.)	Tektites
Pleistocene		0.71±0.10	Australites
	1	1.2±0.2	Ivory Coast
Pliocene			
	13	14.7±0.7	Moldavites
Miocene			
	25	28.6±2	Libyan Desert Glass
Oligocene			
	36	34.7±2	Bediasites
Eocene			
	58	?	?
Palaeocene			
	63	?	?
Cretaceous			

It seems likely that interesting studies could be made by biologists and palaeontologists in regard to the selection of survivors of such catastrophes. It will most probably be millions of years before the next collision occurs, but survivors of such an event would now most probably need to be able to survive the intense radioactivity from nuclear power plants which will be scattered over the entire Earth's surface. As I stated previously, "If the present suggestion gives the true origin" of tektites and also of breaks in the geologic record, "all will agree that any demonstration of the process would cost far more than the scientific knowledge gained would justify."

I am indebted to Professor Shao-Chi Lin for some suggestions in regard to this paper.

HAROLD C. UREY

Chemistry Department,
University of California at San Diego,
La Jolla, California 92037

Received December 1, 1972.

1 Urey, H. C., *Nature*, **179**, 556 (1957).
2 Urey, H. C., *Nature*, **197**, 228 (1963).
3 Urey, H. C., *Science*, **137**, 746 (1962).
4 Durrani, S. A., *Nature*, **235**, 383 (1972).
5 Russell, H. N., Dugan, R. S., and Stewart, J. Q., *Astronomy*, 446 (Ginn and Co., New York, 1945).
6 Whipple, F. L., in *Moon, Meteorites and Comets* (edit. by Middlehurst, B. M., and Kuiper, G. P.), chapter 19 (Chicago Univ. Press, 1963).
7 Lin, S. C., *J. Geophys. Res.*, **71**, 2427 (1966).
8 Laurence Kulp, J., *Science*, **133**, 1106 (1961).
9 Durrani, S. A., *Phys. Earth Planet. Int.*, **4**, 251 (1971).
10 Storzer, D., and Wagner, G. A., *Earth Planet. Sci. Lett.*, **10**, 435 (1971).

Origin of Elements

WE believe the recent report in *Nature*[1] under this title to be misleading in the light of recent observations. The recent measurement[2] of $a = {}^{12}C/{}^{13}C = 75$ (+25, −15) for the ζ Oph cloud is interesting but not surprising because it can be regarded as a confirmation of earlier work[3], as pointed out in ref. 1, and the conclusion that the relative abundance of ^{13}C in the ζ Oph cloud seems to be terrestrial is quite straightforward. It would be an unwarranted assumption to extrapolate the results from ζ Oph (and other tenuous clouds) to the dense, dusty regions of both the galactic centre and the Orion Nebula.

Zuckerman *et al.*[4] noted the possible presence of regions of high ^{13}C abundance in both Sgr A and Sgr B2 in their initial detection report of the ^{13}C isotope for formaldehyde. Whiteoak and Gardner[5] have continued the study of $H_2{}^{13}CO$ and find optical depths which are consistent with a $^{12}C/^{13}C$ abundance ratio no greater than half the terrestrial ratio—a result which supports an earlier conclusion[6] (from $H_2C^{18}O$ observations) that the $^{12}C/C^{13}$ abundance ratio in Sgr B2 is considerably less than the terrestrial value. In addition, Fomalont and Weliachew[7] have now used interferometric measurements to determine $^{12}C/^{13}C \sim 25 \pm 5$ for Sgr A and ≥ 20 for Sgr B2. We believe that the abundance anomalies in formaldehyde reported by Zuckerman *et al.*[4] have been substantiated by three independent types of subsequent observations.

Within the solar neighbourhood, the HCN detection report[8] ($J = 1$–0) indicated that the $^{12}C/^{13}C$ abundance ratio is possibly anomalous in the Orion Nebula; but saturation effects were unknown at the time. Since then, Wilson *et al.*[9] have measured the $J = 2$–1 transition and reported $H^{13}C^{14}N/H^{12}C^{15}N$ to be consistent with the terrestrial ratio, a result which has been interpreted to mean that the $^{12}C/^{13}C$ abundance ratio is probably normal. Subsequently, the hyperfine components of the $J = 1$–0 $H^{12}C^{14}N$ line were observed in Orion (L. E. S. and D. B., unpublished) and found to have almost normal intensity ratios—suggesting that this line is not heavily saturated and hence $H^{13}C^{14}N$ may be overabundant. Finally, the recent detection[10] of DCN gives a DCN/HCN abundance ratio more than an order of magnitude greater than terrestrial. Thus abundance ratios determined from measurements of HCN isotopes in the Orion Nebula may well be non-terrestrial; at present the correct interpretation is uncertain.

We note that recent radio measurements[11] of diatomic molecules such as CO give isotopic ratios consistent with terrestrial values in the Orion Nebula. It is possible that simple molecules have abundance ratios close to terrestrial while more complex species do not; thus isotopic abundances may reflect the dominant formation mechanism for each interstellar species. For example, if interstellar CO is formed primarily in the vapour phase, we might expect CO isotopic ratios which are similar to those of the ambient atoms (possibly terrestrial) but, if HCN formation or depletion relies on interstellar dust grains, we may find non-terrestrial HCN isotopic abundances. Optical abundance determinations from diatomic molecules such as CH^+ which are (by necessity) observed in tenuous interstellar clouds should be applied with great caution to dense dusty regions. Finally, although interpretation of radio measurements is often non-trivial, we believe that in the long run radio observations promise to be the most powerful ground-based tool we have for abundance ratios.

L. E. SNYDER

Astronomy Department,
University of Virginia,
Charlottesville, Virginia 22903

D. BUHL

National Radio Astronomy Observatory,
Green Bank, West Virginia 24944

B. ZUCKERMAN

Astronomy Department,
University of California at Berkeley,
Berkeley, California 94720

1 Cosmology correspondent, *Nature Physical Science*, **239**, 81 (1972).
2 Vanden Bout, P. A., *Astrophys. J. Lett.*, **176**, L127 (1972).
3 Bortolot, V. J., and Thaddeus, P., *Astrophys. J. Lett.*, **155**, L17 (1969).
4 Zuckerman, B., Palmer, P., Snyder, L. E., and Buhl, D., *Astrophys. J. Lett.*, **157**, L167 (1969).
5 Whiteoak, J. B., and Gardner, F. F., *Astrophys. Lett.*, **11**, 15 (1972).
6 Gardner, F. F., Ribes, J. C., and Cooper, B. F. C., *Astrophys. Lett.*, **9**, 181 (1971).
7 Fomalont, E. B., and Weliachew, L., *Astrophys. J.* (in the press).
8 Snyder, L. E., and Buhl, D., *Astrophys. J. Lett.*, **163**, L47 (1971).
9 Wilson, R. W., Penzias, A. A., Jefferts, K. B., Thaddeus, P., and Kutner, M. L., *Astrophys. J. Lett.*, **176**, L77 (1972).
10 Jefferts, K. B., Penzias, A. A., and Wilson, R. W., *Astrophys. J. Lett.* (in the press).
11 Penzias, A. A., Jefferts, K. B., Wilson, R. W., Liszt, H. S., and Solomon, P. M., *Astrophys. J.* (in the press).