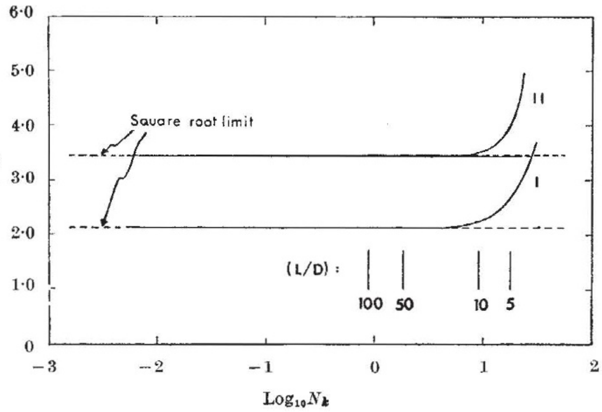

Fig. 2. Overall flux ratio for capillary of typical dimensions; helium–argon (I) and hydrogen–argon (II) at 1 atm., 300° K

than at extreme conditions of pressure or temperature—in which case selective surface migration would probably be an important transport mechanism and flux ratios would be determined by other considerations.

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ASTRONOMY

Evidence of an Ephemeral Earth Satellite

The possibility that the Earth could acquire natural satellites from the debris of large meteoritic impacts on the Moon has been discussed by O'Keefe[1]. A possible capture mechanism for bodies into temporary Earth orbit has been investigated by Baker[2]. On February 9, 1913, a widely observed, long duration procession of meteors and fireballs gave rise to the suggestion by Chant, Mebane, and others[3] that they actually were such ephemeral Earth satellites which were finally consumed at perigee. More recently, a long, extremely narrow field of both craters and meteorites in Argentina was investigated by Kohman *et al.*[4] and they suggested that these were the end-result of a captured Earth satellite finally spiralling into the denser atmosphere.

During the mid-fifties I analysed evidence of two swarms of such objects in retrograde orbits[5]. However, it has never been conclusively proved that such an ephemeral satellite, with a perigee in the upper atmosphere, has been observed while in orbit and before its final revolutions. I now suggest that the Earth has had such a satellite and that it was observed at least eight times during the period 1956–65. Fortunately, these eight known observations were recorded with sufficient accuracy to permit the determination of an orbit. These observations are listed in Table 1.

The first three observations were accidentally made by Metcalfe and forwarded to me[6] as possible evidence of an inner planet. The brilliance of the objects to the naked eye caused most persons contacted to doubt that they were astronomical despite the fact that this was confirmed with optical aids. However, when Kayser and I made the fourth observation (also with optical aid) I computed an approximate orbit, assuming all four observations to be of an Earth satellite. Continued surveillance over the next 60 days during every possible evening twilight period resulted in the fifth and sixth observations being made.

Table 1

Long.	Lat.	Date	Time	Azimuth	Elevation	Magnitude	Observer
87·7 W.	39·6 N.	Nov. 17	01 : 20	248	20		E. Metcalfe
		1956	01 : 33	242	0		E. Metcalfe
87.7 W.	39.6 N.	May 24	01 : 20	291	20		E. Metcalfe
		1957	01 : 37	291	0		E. Metcalfe
87.7 W.	39·6 N.	Nov. 10	23 : 30	287	40		E. Metcalfe
		1957	23 : 58	287	0		E. Metcalfe
118.5 W.	34.0 N.	Dec. 9	03 : 32	233	19		B. Kayser
		1964	03 : 35 : 40	260	3·5	3	J. P. Bagby
118.5 W.	34·0 N.	Dec. 29	02 : 20 : 39	250	12·5	2	J. P. Bagby
		1964	02 : 22 : 24	280	5	2	J. P. Bagby
118.5 W.	34.0 N.	Jan. 10	02 : 16 : 48	278·5	5·5	3	J. P. Bagby
		1965	02 : 16 : 56	280	5	3	J. P. Bagby
118.5 W.	34.0 N.	Oct. 25 1965	02 : 08	231	23	2	R. M. Hartmann
			02 : 11	281	4·5	2	J. P. Bagby
118·5 W.	34·0 N.	Dec. 14	02 : 57 : 09	303·5	30	3·5	J. P. Bagby
		1965	03 : 00 : 10	296	13	3·5	J. P. Bagby

Table 2

	Nov. 17.0, 1956– Dec. 29.0, 1964	Dec. 29·0, 1964– Oct. 25.0, 1965	Oct. 25·0, 1965– Dec. 14.0, 1965
a	$14{,}600-0{\cdot}109\,t$	$14{,}300-0{\cdot}109\,t-1{\cdot}52\times10^{-2}\,t^2$	$12{,}900-9{\cdot}24\,t-1{\cdot}03\,t^3$
e	$1{\cdot}00-(6{,}600/a)$	$1{\cdot}00-(6{,}600/a)$	$1{\cdot}00-(6{,}600/a)$
i	137·4°	137·4°	137·4°
R.A. Node	$86°+0{\cdot}820\,t+6{\cdot}38\times10^{-6}\,t^2$	$52°+0{\cdot}858\,t+3{\cdot}56\times10^{-4}\,t^2$	$342°+1{\cdot}071\,t+9{\cdot}40\times10^{-3}\,t^2$
π	$27-0{\cdot}130\,t-1{\cdot}52\times10^{-6}\,t^2$	$347-0{\cdot}139\,t-5{\cdot}50\times10^{-5}\,t^2$	$300-0{\cdot}172\,t-1{\cdot}52\times10^{-3}\,t^2$
Period	$294-3{\cdot}03\times10^{-3}\,t$	$285-3{\cdot}03\times10^{-3}\,t-4{\cdot}45\times10^{-4}\,t^2$	$244-0{\cdot}270\,t-2{\cdot}70\times10^{-3}\,t^2$
Epoch	Nov. 17·0, 1956	Dec. 29.0, 1964	Oct. 25.0, 1965

In the equations: the semimajor axis (a) is in km; the eccentricity (e) would be 0·00 for a circular orbit and 1·00 for a parabolic orbit; the inclination (i) exceeds 90° due to the retrograde sense of the orbit; the longitude of perigee (π) is the algebraic sum of the right ascension (R.A.) of the node and the argument of perigee; the anomalistic period is in mean solar minutes; and the symbol t is the number of mean solar days elapsed since the epoch.

The fifth observation was made with optical aid, but the sixth was by naked eye only. These further observations made it possible to improve the determination of the orbits, and osculating orbits were distributed to about twenty individuals and astronomical agencies.

During most of 1965, no one else reported to me that they had seen the object. Then Hartmann and I made the seventh observation, and this further extended the orbit description. It also led to another period of evening twilight surveillance, which resulted in an eighth observation being made and further orbital refinement. These new results on orbits were recently distributed to thirty individuals and astronomical agencies, but so far no one else has reported an observation to me. It is probable that the object decayed in the Earth's atmosphere during January 1966. The orbital elements are given in Table 2.

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GEOPHYSICS

Temperature and Fractional Melting in the Upper Mantle

The velocities of compressional (V_P) and distortional (V_S) seismic waves, through the Earth's upper mantle, were computed with much detail by Gutenberg[1], who found the existence of a low-velocity layer at depths greater than about 70 km.

At least in the lower mantle, where the thermal gradient is expected to be nearly constant, Bullen[2] found that the bulk modulus ($\varkappa$) and the rigidity (μ) have a reasonably linear variation with depth, or with pressure which may be considered proportional to depth. Therefore, it was