Reports

Low-Latitude Noctilucent Cloud of 2 November 1963

Abstract. *Measurement of the filamentary noctilucent cloud of 2 November 1963 yields a height of 56 km. Study of the motion and orientation of the cloud confirms the hypothesis that these unusual clouds appearing in the southwestern states are produced by the launching of rocket vehicles from the Pacific Missile Range.*

On 15 June 1963 a noctilucent cloud was observed (*1*) which had a height of 71 km and an orientation and drift vector that indicated an origin from the Pacific Missile Range. Proper instrumentation was available to permit a more accurate measurement of the cloud that appeared on 2 November 1963. At the time the equipment was being used to study the height of the volcanic dust from Agung (*2*) as illuminated by the set sun. After the primary glow stratum was occulted by the earth's shadow, the darkening sky showed a white filamentary cloud in the direction, WNW. It was immediately apparent that a noctilucent cloud was becoming visible, and its white color indicated that it was not simply a low-lying cloud illuminated by the glow stratum.

Three 35-mm photographs of 6- to 30-sec duration at *f*/3.5 were obtained on Kodachrome film. The time that the sun set on the cloud was recorded for four points on the cloud. Subsequent measurement of the points along the cloud yielded heights, range, and velocity for the cloud. The locations of the cloud in space are shown in Figs. 1 and 2. The velocity, vector, and orientation, shown in Fig. 1, again places the east end of the cloud close to the Pacific Missile Range at 2:15 P.M. PST, indicating that a missile was probably launched toward the south-Pacific impact area. No data confirming the launching of a ballistic missile is on hand; however, the evidence seems quite conclusive.

While the measurement of noctilucent clouds from 28-mm focal length 35-mm films is subject to rather appreciable errors, the independent measures of velocity from different portions of the cloud agree within 5 per cent. The scatter in observed points in Figs. 1 and 2 indicate that the orientation of the cloud in space is linear and inclined upward toward the southwest. The altitudes shown in Fig. 2 have been corrected for −3.7 km refraction of sunlight past the tangent point of the solar rays. Since the observed time of sunset was used to keep time measurements on a homogeneous basis, the second refraction term is eliminated. A screening height of +1.8 km is assumed, based upon earlier experience (*2*), yielding a net correction to the geometrical heights of −1.9 km. The mean height of the cloud is 56 km, distinctly lower than the 71 km observed for a similar cloud (*1*).

The observations on the cloud (*1*) of 15 June supplied insufficient data to detect whether the cloud lay at a constant level. In the case of the cloud of 2 November we can definitely state that the cloud was inclined in space. As a consequence we must be cautious in interpreting the azimuthal orientation since wind shear over 10 km of altitude can appreciably modify the original cloud in the 3 hours required for the cloud to arrive in the vicinity of Yuma. The appearance of the cloud, consisting of two closely parallel streaks, does not indicate appreciable nonlinear shear since both are only mildly contorted in identical manner with the intervening region filled with less conspicuous cloud. Several points of sun-illuminated cloud were observed near the horizon below the eastern end of the cloud, indicated by the dotted line in Fig. 1. The height and range of these fragments could not be determined.

The coincidence of the clouds of 15 June and 2 November 1963 with a drift vector indicating origin from the Pacific Missile Range would appear to remove the probability of a fortuitous occurrence that could have been argued from one cloud alone. The height of 56 km removes this cloud from any connection with the Agung volcanic dust layer (20 km) (*2*) or with the 80-km region associated with the occurrence of natural high-latitude noctilucent clouds (*3*). Newkirk (*4*) has recently reported a nacreous cloud observed after the set of the volcanic glow stratum on 25 September 1963 for which he derives a height of 33 km. The filamentary structure of his cloud is quite similar to that observed by us on 2 November, but the altitude is definitely lower and the cloud is probably of different origin.

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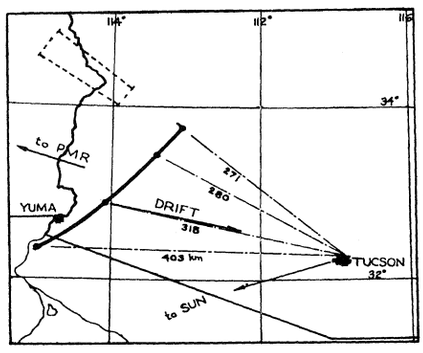

Fig. 1. The observed range and orientation of the noctilucent cloud of 2 November is shown with respect to Tucson and the direction of the Pacific Missile Range.

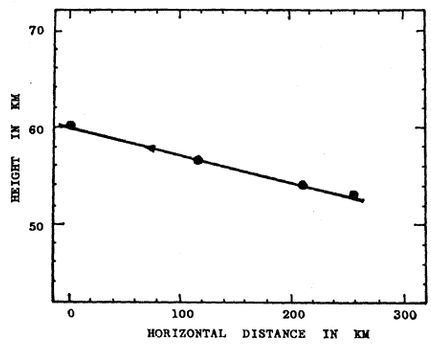

Fig. 2. The heights computed for the cloud at points along its length indicate that the cloud is linear and inclined upward toward the southwest end.

References and Notes

1. A. B. Meinel, B. Middlehurst, E. Whitaker, *Science* **141**, 1176 (1963).
2. M. P. Meinel, A. B. Meinel, *ibid.* **142**, 582 (1963).
3. R. K. Soberman, *Sci. Am.* **208**, 50, 1963.
4. G. Newkirk, private communication, 1963.

26 November 1963

Pyrene and Fluoranthene in Manganese Nodules

Abstract. *The polynuclear aromatic hydrocarbons pyrene and fluoranthene have been isolated from manganese nodules of the western North Atlantic.*

Polynuclear aromatic hydrocarbons occur in many geological materials, including recent marine, inshore sediments (*1*). The hydrocarbon content of a marine mineral deposit of high redox potential has now been investigated and the four-ring aromatics pyrene and fluoranthene have been isolated.

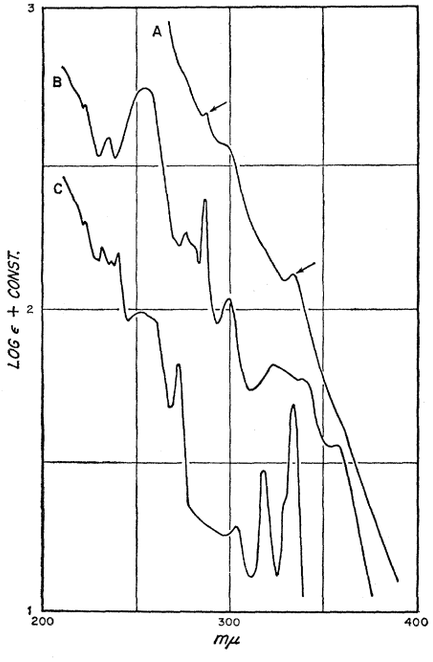

Fig. 1. *A*, Total isooctane-benzene fraction; *B*, fluoranthene from GLC; *C*, Pyrene from GLC.

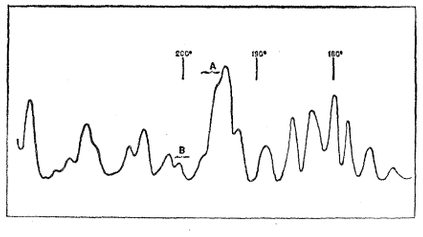

Fig. 2. Gas chromatogram of total isooctane-benzene fraction.

The manganese nodules used in this investigation were collected from the Blake Plateau (*2*). Two nodules were examined separately, giving similar results (Table 1).

After grinding to less than 200 mesh, samples were extracted with chloroform and the extracts were chromatographed on activated alumina with graded eluents composed of isooctane, benzene, and diethylether. An ultraviolet spectrum (*3*) (Fig. 1) of the fraction eluted with a mixture of isooctane-benzene (4:1) showed principal maxima for pyrene and fluoranthene at 334 and 287 mμ.

A gas chromatogram (*4*) (Fig. 2) indicated many compounds in this fraction. Shoulder A had the retention time of synthetic fluoranthene, and peak B corresponded to pyrene. Each of these components was collected by condensation in glass capillary tubes inserted into the gas chromatograph outlet. The capillaries were then rinsed with isooctane. Ultraviolet absorption spectra (Fig. 1) of the resulting solutions confirmed the presence of pyrene and fluoranthene. Incomplete chromatographic separation accounts for additional peaks in the spectra.

All concentrations given in the table are based on ultraviolet spectra of the total chromatographic fraction containing both hydrocarbons. The absorption maxima mentioned above were used for the calculations, after a correction for high background absorption.

Spectra of all fractions in the alumina chromatogram were examined for the presence of other hydrocarbons; however, none were detected. The other compounds indicated in the gas chromatogram, some in significant concentrations, were not further investigated. They lacked characteristic ultraviolet spectra, which made possible the identification of the hydrocarbons on a microgram scale.

Pyrene and fluoranthene are the two most abundant polynuclear hydrocarbons in sea water, with the latter in larger concentration (*5*). These compounds may have been adsorbed from the sea water during the formation of the manganese nodules. However, the possibility that they were formed *in situ* by organisms living on the nodules, such as bacteria, cannot be excluded. This finding extends the known range of natural occurrence of polynuclear hydrocarbons and suggests that compounds of this type can be well preserved in strongly oxidized sediments deposited under high redox potentials.

Table 1. Hydrocarbon concentrations.

Manganese nodules (g)	Hydrocarbons (10^{-8} ppm)	
	Pyrene	Fluoranthene
283	2	4
338	6	8

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References and Notes

1. W. G. Meinschein, *Bull. Am Assoc. Petrol. Geologists* **43**, 925 (1959).
2. 30°53′N, 78°47′W, 445 fathoms, *Atlantis* cruise No. 266.
3. Cary recording spectrophotometer, Model 14.
4. Aerograph HyFI, model 600, with hydrogen flame detector and linear temperature programmer. Column: 0.3 cm by 1.8 m of 5 percent Dow Corning RTV 502 on 80/100 mesh acid-washed, silanized Chromosorb W.
5. M. Blumer, unpublished data.
6. Supported by research contracts with the U.S. Navy Bureau of Ships and the U.S. Office of Naval Research [Nonr 2196 (00)] and by the grant of a Woods Hole Oceanographic Institution summer student fellowship to one of us (D.W.T.). The manganese nodules were collected by T. R. Stetson. This report is contribution No. 1430 of the Woods Hole Oceangraphic Institute.

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Hydrogen in a Tektite Vesicle

A philippinite, No. PO-301, found by E. C. T. Chao at the Rafael Ortegas site, Mandalayong, Philippine Islands, was shown by P. D. Lowman, Jr., to have a specific gravity of 2.04, which, taken in conjunction with a mass of 11.10 grams and a presumed specific gravity of the stony material of 2.45 indicates an internal bubble with a volume of 0.89 cm^3. When the contained gases were excited by an electrodeless discharge at the Goddard Space Flight Center by the technique of O'Keefe, Dunning, and Lowman (*1*), the spectrum consisted almost exclusively of the so-called second spectrum of hydrogen, that is H_2, between 6225 and 5949Å every line with an intensity 10 in Gale *et al.* (*2*) was found; in addition, only one other line, of intensity 8, was measured. Shortward of 5949Å the corespondence was poorer; nevertheless, all lines could be explained as due to H_2, with the possible ex-