properties of this rock and contribute to its hard magnetic component (*5*). Low-grade metamorphic breccia produced from soil containing these VLS-type stalks would then contain metallic iron needles of the single domain or pseudo-single domain type (*5*).

Since VLS-type growth has probably occurred in many impact situations on the lunar surface, it may have been an important growth mechanism in the early accretionary history of the earth, especially before it acquired an appreciable oxidizing atmosphere, and on other planets.

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6. I thank D. S. McKay of the Lyndon Baines Johnson Space Center, Houston, Texas, for taking the high-magnification SEM photograph shown in Fig. 1D, and J. B. Toney for technical assistance. Supported by NASA grant NGR-44-004-116. Contribution No. 235 of the Institute for Geological Sciences, University of Texas at Dallas.

6 April 1973; revised 25 June 1973 ■

Toxic Metal Fumes from Mantle-Type Camp Lanterns

Abstract. *The mantle of a gas lantern contains about 600 micrograms of toxic beryllium metal. Most of the beryllium is volatilized and becomes airborne during the first 15 minutes of use of a new mantle. The inhalation of this quantity of beryllium can be hazardous.*

The users of mantle-type lanterns, while familiar with the fire risks associated with them, may be unaware of another very serious hazard, namely, the emission of toxic fumes from the mantle. The mantle is made up almost entirely of the oxides of thorium (95 percent), magnesium, aluminum, cerium, beryllium, and silicon. It is the presence of beryllium which poses the greatest threat.

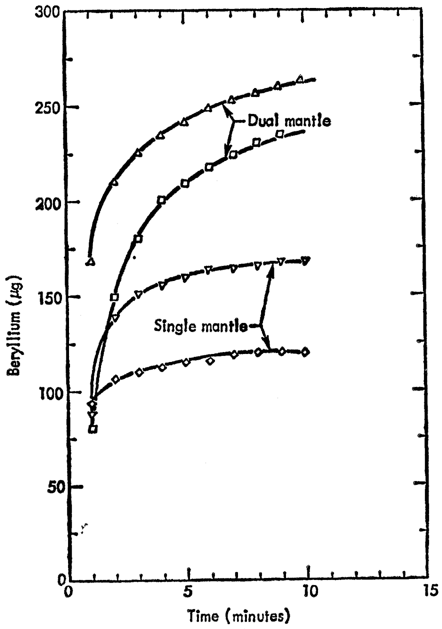

Fig. 1. A plot of airborne beryllium emission versus time for two single-mantle and two dual-mantle lanterns.

The results of an analysis of the beryllium content of eight new, unused mantles were reasonably consistent, with values ranging from 550 to 700 μg with an average content of 650 μg. After 1 hour's use in a lantern, the mantle residues were found to contain from 112 to 288 μg of beryllium, with an average content of about 200 μg. Most of the missing 400 μg of beryllium had volatilized and become airborne in the first 15 minutes of mantle use (see Table 1).

Another potential hazard arises from radioactive thorium (and its daughters), even though the mantles are in no way labeled to suggest the presence of radioactive elements. The thorium can emit from 150,000 to 300,000 alpha particles per minute. Although the thorium in the mantle does not appear to volatilize and become airborne during use, certain of the daughter products do. These products decay fairly rapidly.

It is useful to review some details of the construction and operation of these mantles. The mantle is prepared by dipping rayon fabric into a solution of the nitrates of thorium, cerium, and beryllium. Magnesium, aluminum, and silicon are also present in small quantities. The thorium is the material which incandesces when the mantle is heated to a high temperature. The cerium's function is possibly to improve upon the whiteness of this incandescence, and the beryllium is added to harden the delicate ashlike structure of the mantle. After drying, the mantle is coated with nitrocellulose to "fix" the salts to the fabric support material. The nitrocellulose also assists in the preburning of the mantle. Preburning is carried out with a match but in the absence of fuel to prepare the mantle for its initial use. This simple ignition is kindled by the combustible nitrocellulose coating and burns away the fabric support material, converting the thorium, cerium, and beryllium nitrates to their respective oxides.

I sampled the airborne beryllium content by placing the lantern in a transparent enclosure [2 cubic feet (0.056 m^3) in volume] that was open on the bottom and set over a honeycomb material to diffuse the incoming air. The chamber had an opening at the top through which air samples could be taken. Air was swept through the opening at the bottom of the container past the lantern so that any particles of beryllium in the air would be deposited on the paper in the sampler. This paper was then analyzed for beryllium by fluorometry or atomic absorption spectrophotometry, or both.

In two of these tests (tests 1 and 2, Table 1) the initial samples were taken during the preburning, during which smoke and soot are given off. I suspected that beryllium might be

Table 1. Airborne beryllium emissions from gas lanterns containing new, unused single mantles.

Sample time (cumulative) (minutes)	Beryllium collected (cumulative) (μg)	Condition
	Test 1	
30	1.25	No fuel
45	181	Fuel
66	189	Fuel
96	195	Fuel
126	198	Fuel
	Test 2	
5	0.25	No fuel
35	177	Fuel
66	182	Fuel
156	189	Fuel
	Test 3	
16	182	Fuel
32	196	Fuel
63	202	Fuel
93	205	Fuel
124	207	Fuel
155	209	Fuel
	Test 4	
33	157	Fuel
63	178	Fuel
94	183	Fuel
125	187	Fuel
175	191	Fuel

carried off with this particulate matter. However, an insignificant amount of beryllium was found in the sample taken without fuel. When the lantern was lighted with the fuel turned on, most of the beryllium appeared on the sample paper in the first few minutes. In two of these tests (tests 3 and 4, Table 1) the initial samples were taken with the fuel turned on. In these tests the beryllium evolved at once. Sampling at varying intervals revealed that the beryllium emissions were immediately high and decreased rapidly. The total beryllium collected from each mantle was rather consistent at about 200 μg (Table 1). When the sampling period was shortened to 1-minute intervals, I observed that most of the beryllium was evolved in the first 2 minutes after lighting (Fig. 1). Actually the beryllium was released so fast that the quantities collected in the first minute of use equaled or exceeded the amount of beryllium subsequently emitted (Fig. 1).

Under these test conditions the sampler was exhausting air through the box at a rate of 25 cubic feet (0.70 m^3) per minute. This resulted in 12 changes of air per minute in the enclosure. These conditions do not occur in the normal use of the lantern. In normal use, less beryllium would be expected to evolve from the lantern with deposition being the greatest on the inner surface of the lantern cap. A gentle cleaning of the cap after 30 minutes of cumulative use over a period of 4 months produced 100 μg of beryllium.

The dual-mantle type of lantern emits about 50 percent more beryllium than the single-mantle type of lantern. When such a dual-mantle lantern was functioning properly so that it burned brightly at once, half of the beryllium that was emitted was given off in the first minute of a 10-minute test. In one experiment I had difficulty maintaining a brightly burning mantle because of a faulty fuel gasket. In this case the beryllium emissions were lower, but the mantle continued to evolve beryllium for a prolonged period. This resulted in a near equal total beryllium release over the 10-minute period (Fig. 1).

The inhalation of beryllium may produce two forms of beryllium disease. The chronic form can develop from exposure to low concentrations of beryllium over a long period of time, perhaps many years. To protect against this hazard industrial hygienists recommend that exposures not exceed 2 μg per cubic meter of air averaged over an 8-hour period (*1*). This level is set for the protection of those whose occupation requires that they work with beryllium. Nonoccupational limits, for people of varying susceptibility who may be exposed to this environment 24 hours a day, are much lower, 0.01 μg of beryllium per cubic meter of air averaged over a month.

The acute form could result from a single exposure to a high concentration of beryllium for a brief time. To protect against this form, it is recommended (*1*) that concentrations in excess of 25 μg of beryllium per cubic meter of air never be exceeded. A large camper has a volume of approximately 14 m^3. If the 260 μg of beryllium collected from a dual-lantern mantle (Fig. 1) were distributed uniformly throughout this volume, the average concentration would be 18 μg per cubic meter.

The process of lighting a new mantle can be particularly hazardous since it involves working the cleaning wire and slowly opening the fuel valve full as the mantle begins to burn brightly. This requires from about 1 to 2 minutes, the period during which the new mantle is emitting most of the beryllium. To carry out this operation the user usually places his face in close vicinity to the mantle and can inhale emissions from the mantle. Furthermore, when replacing and disposing of the old mantles, one should attempt to contain the light fluffy residue in order to limit contamination of the area. This is particularly important if the lantern is permanently installed in a camper or trailer.

The company which produces the brand of mantle tested manufactures 17×10^6 mantles each year. It is reasonable to assume that this number is sold and used each year. It is quite likely that many people are unnecessarily exposed to the dangers associated with beryllium inhalation simply because they are unaware of the hazard present during the first few minutes after the lighting of a new mantle.

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19 March 1973; revised 18 June 1973

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Mercury in the Greenland Ice Sheet: Further Data

Abstract. *New data support the contention that the mercury content of Greenland glacial ices has not increased dramatically in recent years but rather is distributed nonhomogeneously through the ice sheet.*

Weiss *et al.* have reported measurements of the mercury content of Greenland glacial ices by neutron activation techniques (*1*). On the basis of data obtained from two separate sites (Camp Century and a "virgin site"), they concluded that a doubling of the mercury content had occurred in recently deposited ice layers. Dickson has pointed out that the data from the two sites did not overlap in time, which prevented an intersite calibration (*2*).

We have analyzed ice core samples from Camp Century (77°10′N, 61°08′W) and site 2 (76°59′N, 56°04′W) by flameless atomic absorption spectrometry (*3*). Our data allow an intersite comparison because an overlap in time exists in the data. The "virgin site" is roughly midway between Camp Century and site 2 (*4*).

Table 1. Total mercury concentrations in four Greenland glacial ices.

Sample	Depth (m)	Date	Mercury (ng/liter)
Camp Century	56.94	1850	13 ± 10
Site 2	54.12	1870	169 ± 15
Site 2	21.59	1930	100 ± 12
Camp Century	13.75	1940	50 ± 10

A distinct difference can be seen between the mercury content of the two sites, a finding that lends support to Dickson's contention that the horizontal distribution of mercury through the ice cap is heterogeneous (*2*). Siegel *et al.* have reported a high mercury content in volcanic ash from Icelandic volcanic sources and indicated that winds do exist which could transport this mercury to Greenland (*5*). Correlations between the mercury content of ice and world volcanic activity are tenuous at best, although volcanic chronologies are available (*6*).

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