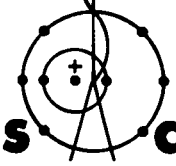
LA-4943

c.3

Effect of Soil and Weather on the Decomposition of Explosives

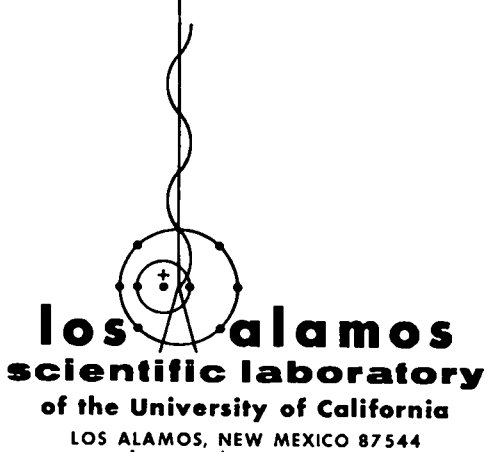


los alamos
scientific laboratory
of the University of California
LOS ALAMOS, NEW MEXICO 87544

UNITED STATES
ATOMIC ENERGY COMMISSION
CONTRACT W-7405-ENG. 36

Printed in the United States of America. Available from
National Technical Information Service
U. S. Department of Commerce
5285 Port Royal Road
Springfield, Virginia 22151
Price: Printed Copy $3.00; Microfiche $0.95

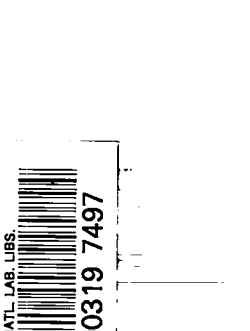
LA-4943
UC-70
ISSUED: June 1972



Effect of Soil and Weather on the Decomposition of Explosives

by

F. W. DuBois
J. F. Baytos



EFFECT OF SOIL AND WEATHER ON THE DECOMPOSITION OF EXPLOSIVES

by

F. W. DuBois and J. F. Baytos

ABSTRACT

Twelve high-explosive materials were buried in soil and exposed to the elements to determine their rate of disappearance from the environment. Only those explosives that contained TNT, barium nitrate, and boric acid disappeared at a useful rate.

I. INTRODUCTION

Experiments were undertaken to determine the persistence of explosives in the area surrounding a drop tower at Los Alamos Scientific Laboratory (LASL) technical area TA-11, which is used in testing the sensitivity of explosives to impact. A location with soil, topography, flora, and weather conditions typical of the area surrounding the tower was selected. Soil was removed, mixed with explosives, replaced, and analyzed periodically for residual explosives.

The exposed explosives were PETN, HMX, RDX, TNT, Octol,* Cyclotol,** Composition B-3,*** PBX 9404,† PBX 9011,†† PBX 9010,††† Boracitol,∇ and Baratol.Δ Tests were also run with Pseudomonas aeruginosa, but the bacteria did not survive.

The disappearance of the materials with time is shown in Figs. 1 through 4. Only those explosives containing TNT, barium nitrate, or boric acid disappear at a rate that can be considered useful for their effective elimination from the environment.

II. EXPERIMENTAL

Sample Preparation

Soil from the test site was screened through a 1/4- by 1/4-in. wire screen and dried to a moisture content of 0.25 wt %. Three sets of samples were prepared.

1. The first set consisted of 12 samples, each containing 0.1 wt % of one of the 12 explosives. Five g of the powdered explosive was mixed with 5 kg of soil in a Patterson-Kelly twin-shell blender.

2. A second set of four samples containing 0.1 wt % PBX 9404, PBX 9010, PBX 9011, and Comp. B-3, respectively, was made up. These samples were analogous to the first set, except that 10 ml of a culture of Pseudomonas aeruginosa was added to each and the water content of each was raised to 20 wt %.

* 75 wt % HMX/25 wt % TNT
** 75 wt % RDX/25 wt % TNT
*** 60 wt % RDX/40 wt % TNT
† 94 wt % HMX/2.95 wt% cellulose nitrate/2.95 wt % CEF/0.1 wt % diphenylamine
†† 90 wt % HMX/10 wt % Estane 5740 X-2
††† 90 wt % RDX/10 wt % Kel-F Elastomer 3700
∇ 40 wt % TNT/60 wt % boric acid
Δ 24 wt % TNT/76 wt % barium nitrate

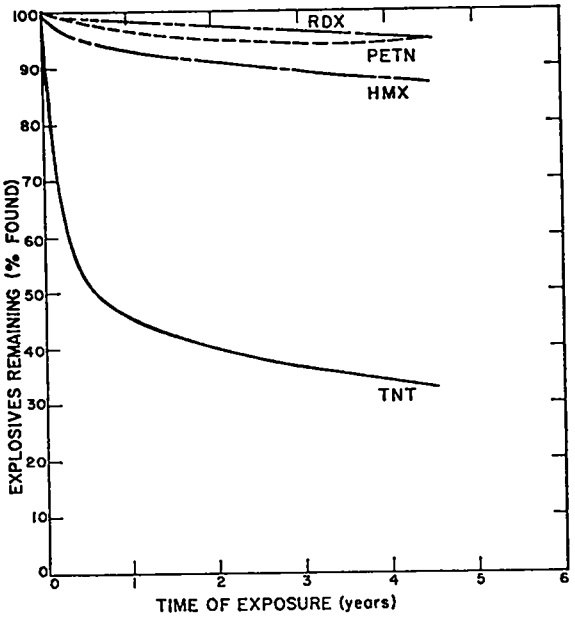


Fig. 1. Percent of individual explosives (TNT, RDX, HMX, and PETN) found remaining in soil sample after exposure to weathering. Original ratio of explosive to soil weight was 1//000.

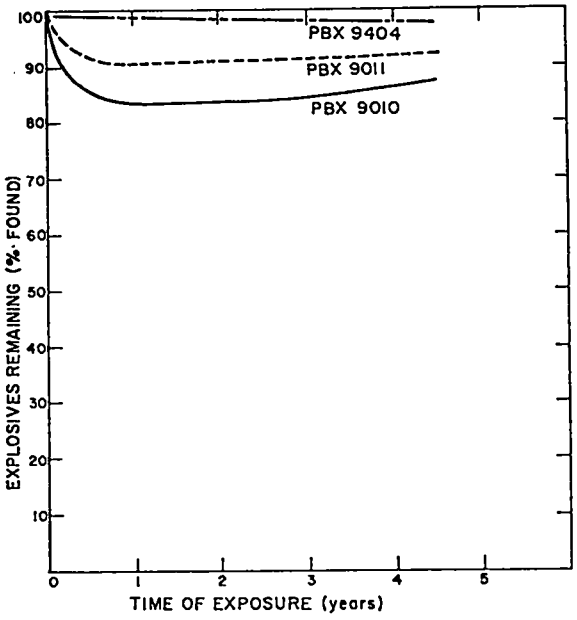


Fig. 3. Percent of plastic bonded explosives (PBX's 9404, 9010, and 9011) found remaining in soil sample after exposure to weathering. Original ratio of explosive to soil weight was 1/1000.

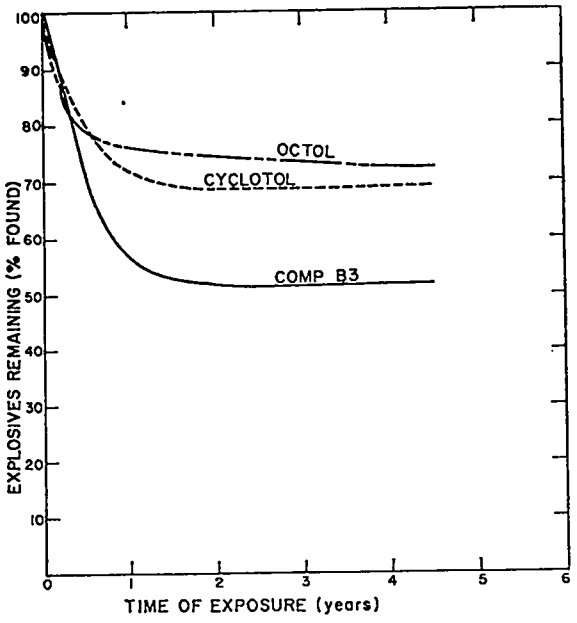


Fig. 2. Percent of cast explosives (Comp. B-3, Cyclotol, and Octol) found remaining in soil sample after exposure to weathering. Original ratio of explosive to soil weight was 1/1000.

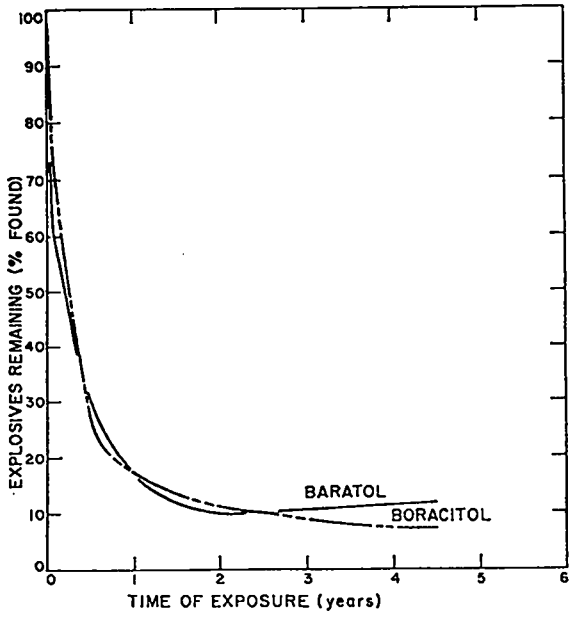


Fig. 4. Percent of cast explosives made with water-soluble inorganics (Baratol and Boracitol) found remaining in soil sample after exposure to weathering. Original ratio of explosive to soil weight was 1/1000.

3. A third set of samples consisted of a 5/8-in.-diam by 1/4-in.-high cylinder of each of the 12 explosives buried in the soil.

The sample materials were placed in 7-in.-diam by 6-in.-high sections of Johns-Manville Transite tubing. The tubes had a fine-mesh stainless steel screen on the bottom and hardware cloth over the top. The sample containers were buried in the test area with their tops flush with the surrounding surface.

III. ANALYTICAL

A. Sampling

A 3/4-in.-diam tube was used to remove a 50-g analytical sample from the samples containing powdered explosives. The cylinders of explosive were dug out of the soil by hand.

B. Analysis

The cylinders of explosive were weighed and photographed. Material from the samples containing bacteria was sent to the LASL Industrial Waste Group, H-7, for determination of the numbers of Pseudomonas aeruginosa remaining in the soil. The soil containing powdered explosive was analyzed as follows.

1. The core sample was dried.
2. Ten g of the material was placed in a Soxhlet extractor, and the explosive was extracted with acetone for 3 h.
3. The acetone was evaporated, and the solute was taken up in acetonitrile and diluted to 50 ml.
4. The concentration of explosive was determined using a Perkin-Elmer Model 350 spectrophotometer. The determinations were made in the ultraviolet region at the wavelengths given in Fig. 5.

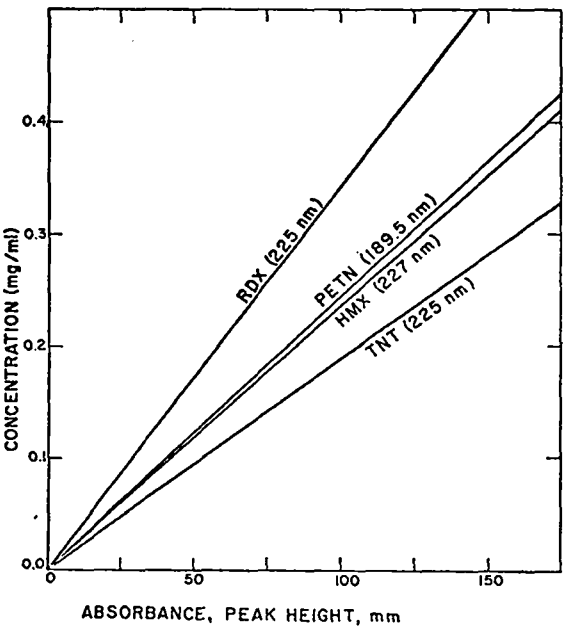


Fig. 5. Lambert-Beer curves of explosives in acetonitrile on the Perkin-Elmer Model 350-UV-VIS-NIR spectrophotometer. Light path - 0.5 mm, cylindrical quartz cells.

IV. DISCUSSION

The disappearance of the powdered explosives as a function of time is shown in Figs. 1 through 4. The amounts of Baratol, Boracitol, Comp. B-3, Cyclotol, and Octol, which contain water-soluble components, decreased with time. RDX, HMX, and PETN changed very little.

The Pseudomonas aeruginosa did not survive. Only 10% were left after 1 month, and they were essentially gone after 6 months.

The Baratol and Boracitol cylinders were severely deteriorated by the environment; the others were not affected to any appreciable extent.

The site for this experiment was selected by Group H-7. The soil is typical of that in the surrounding area, and is probably very much like that of most of the LASL firing sites.

These experiments were instigated by Group GMX-3 in the hope of finding that the explosives would disappear with time. It is clear that this is not the case. Explosives that enter the environment from our operations will be around for a long time.

ACKNOWLEDGMENTS

We thank Edward Wilder, Group GMX-3, for requesting that these experiments be conducted, and E. B. Fowler, Group H-7, for selecting the site and analyzing the bacterial samples.