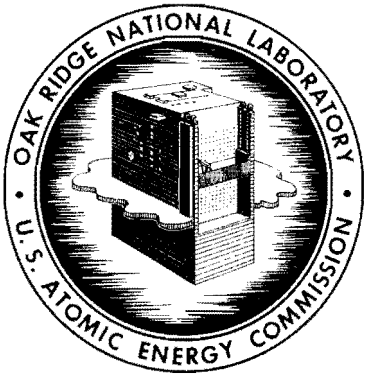

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ORNL - TM - 445

COPY NO. - 4

DATE - January 7, 1963

THE ORNL GAS SAMPLING EXPERIMENT IN CONNECTION WITH THE TAMALPAIS EVENT

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ABSTRACT

Gas samples taken during the first 10 seconds after detonation of the TAMALPAIS device indicated that not more than 3% of the tritium spike underwent exchange with hydrogen in the environmental water. The percentage of tritium in sequenced samples decreased rapidly with post-shot time.

1.0 INTRODUCTION

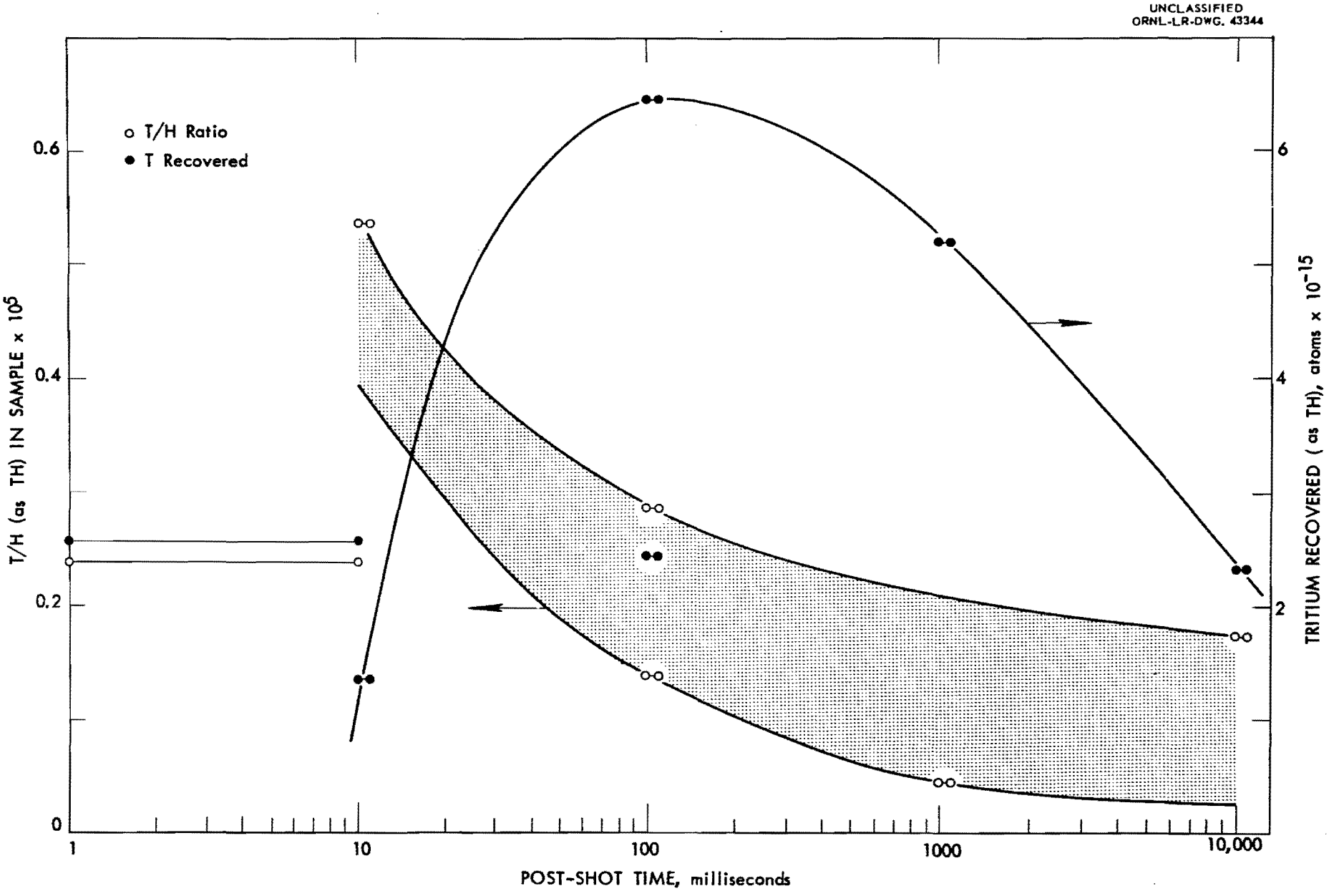
The TAMALPAIS device was exploded in bedded tuff at the National Test Site on Oct. 8, 1958. The nominal yield was 65 (± 20) tons. Phenomenological details of the event are listed elsewhere.[1]

In order to obtain information concerning the chemistry (particularly of hydrogen) during early post-shot time, and the feasibility of recovering prompt gas samples the device was spiked with 0.08 gm of tritium contained in eight sample bottles located at the corners of the cubicle. In order to obtain data of interest in planning the GNOME shot, the device chamber was lined with two feet of salt. This, of course, required the use of a large quantity of shoring material (primarily wood) which produced a great deal of reducing gases that will not be present in the GNOME shot in bedded salt where no shoring material is expected to be necessary.

2.0 EXPERIMENTAL LAY-OUT AND SAMPLER DESIGN

The ORNL sampling system consisted of a group of eight stainless steel sample bottles, each having a nominal volume of 1 cubic foot, which were connected by a tee to a 1-inch pipe leading to a relatively large chamber used by UCRL to collect a cumulative gas sample. The gas sampling arrangement is shown schematically in Fig. 1. The sampling system was evacuated prior to shot time. The ORNL sample bottles were fitted with explosive valves which were actuated by an electronic timer in such a way as to allow samples to be taken over time intervals varying from 1 millisecond to 1 second over the post-shot time from zero to eleven seconds. Details of the ORNL sampling system are described elsewhere.[2]

Due to operational emergencies existing at the NTS and lasting for some weeks thereafter, it was not possible for the ORNL personnel responsible for the samplers to remove them from the sampling alcove or even to examine them after the shot. They were eventually removed and examined by UCRL personnel who found that seven of the eight bottles had obtained gas samples[3] and that the valve on one had failed to operate. It later transpired that the valve on another bottle had leaked[4] leaving six bottles on which the timer and valves had functioned correctly. Post-shot examination showed that the sampling line had ruptured. Since the time of this rupture is not known one cannot be certain that the samples were obtained from the sampling pipe as planned.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ORNL-LR-DWG. 43344
o T/H Ratio
• T Recovered
T/H (as TH) IN SAMPLE x 10^5
TRITIUM RECOVERED (as TH), atoms x 10^-15
POST-SHOT TIME, milliseconds
0
0.2
0.4
0.6
2
4
6
1
10
100
1000
10,000

Table 1. Data from TAMALPAIS Gas Samples

ORNL sample volumes = 28.3 liters
Total number of fissions = 9.8×10^{21} (0.07 kt)
Tracer = 0.08 g, 1.61×10^{22} atoms, 1.72×10^{15} disints/min

	Sample Designation							
	S-1a	S-1b	S-2a	S-2b	S-3b	S-4b	Bottle 22*	Tunnel
Post-Shot Sampling Interval, sec	0.010-0.011	0-0.011	0.1-0.11	0.1-0.11	1-1.1	10-11	---	---
Total Sampling Time, sec	0.001	0.011	0.01	0.01	0.1	1	---	---
Total Fissions x 10^{-15}(Kr^{85})	6.27	19.8(±2.5)	58.5(±9.2)	12.0(±0.5)	94(±11)	43.9	0.043	0.047
H Atoms x 10^{-20}	2.53	10.9	22.4	17.7	116.7	13.6	92.5	2.16
T Atoms as TH x 10^{-15}	1.36	2.58(±0.13)	6.48	2.45	5.21	2.34	0.051	0.0039
T Atoms as THO x 10^{-13}	3.50	7.84	17.0	5.06	7.62	6.1	0.047	0.0037
Sample Volume, STP, liters	6.55	15.6	22.5	11.6	26.5	16.9	---	---
H/T (elemental) x 10^{-5}	1.86	4.2(±0.2)	3.5	7.2	22.4	5.8	1.81×10^{3}	554
T_{TH}/T_{THO}	38.9	32.9	38.1	48.4	68.4	38.4	109	105
Fissions/liter x 10^{-15}	0.96	1.27(±.16)	2.6(±.41)	1.03(±.04)	3.55(±.42)	2.60	---	---
Volume %, H_2	.073	.13	.185	.284	0.82	0.15	1.3	.014
Kr^{85}/T_{HT}	4.6	7.7	9.0(±.14)	4.9(±0.2)	18.0(±2.0)	18.8	0.84	12.0
Total Moles H_2 (from H/T and orig. charge)	2480	5610	4670	9610	3.0×10^{4}	7740	2.4×10^{6}	7.4×10^{5}

*UCRL cumulative sample. See Table 2 for complete chemical analysis.

The gas samples were analyzed at Livermore during early 1959 and the final results submitted to ORNL in April.[5] Preliminary results were made available about a month earlier.[4] The data (Table 1) are not sufficiently accurate to allow quantitative conclusions to be drawn but they appear to indicate that:

(1) The T/H ratio in the gas decreased with time after 10 msec post-shot (Fig. 2).

(2) The total amount of tritium collected decreased with time after about 100 msec post-shot in spite of the fact that the later samples represented longer sampling times.

(3) Only 1-3% of the tritium exchanged with the water in the surroundings.

Data from the LRL cumulative sample and from a specimen of tunnel air, both taken several days post-shot, are included in Table 1 for comparison. The results of the chemical analysis of the gas from the LRL cumulative gas sample are listed in Table 2.[6]

Table 2. Chemical Composition of the LRL Cumulative Gas Sample

Component	Amount in Sample	% in Normal NTS Air
H_2	1.3%	0.01
H_2O	1.7%	1-3
CO_2	0.22%	0.03
HCN	1.7 ppm	
C_2H_6	6.4 ppm	
C_2H_2	8.1 ppm	
C_3H_6	1.5 ppm	

The remainder was O_2 and N_2 with slightly less O_2 than in normal air.

It was estimated that that of approximately 10^6 moles of H_2 produced as much as 0.85×10^6 may have been produced by chemical reactions (e.g., of the shoring material) while as much as 0.35×10^6 could have been produced by the dissociation of water.[5]

A brief summary of the LRL gas collection experience is as follows:[4]

A. LOGAN - 4.5 kt yield. Sampler had a 6-inch pipe, 600 ft long, the mouth of which was located 1 meter from the working point. Sampling bottle volume was 400 cu ft. Bottle was evacuated before sampling. Bomb fraction collected was 7×10^{-13}.

B. TAMALPAIS - 0.07 kt yield. Sampler had a 1-inch pipe 100 ft long, with a 3-inch mouth located about 2 meters from the working point. Bottle was evacuated before sampling. Bomb fraction collected was 10^{-8}.

C. EVANS - 0.05 kt yield. Sampler had a 6-inch pipe, 400 ft long. Bomb fraction collected was 10^{-9}.

The gas fractions collected in these three tests were of the same orders of magnitude as samples of solid fission products collected on gas filters.

4.0 REFERENCES

1. G. W. Johnson and C. E. Violet, "Phenomenology of Contained Nuclear Explosions," UCRL-5124, Rev. I, December 1958.

2. J. W. Landry, "ORNL Sampler for TAMALPAIS Event," ORNL-2881 (in preparation).

3. M. W. Nathans, private communication, Dec. 16, 1958.

4. M. W. Nathans, private communication, March 31, 1959.

5. Letter M. W. Nathans, UCRL to W. E. Clark, ORNL, April 20, 1959.

6. M. W. Nathans, private communication, Jan. 19, 1959.

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