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The Degree of Deterioration of Associated Death Scene Material

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ABSTRACT: Experiments to determine the rate of deterioration of materials commonly found in association with human skeletonized remains at death scenes are described. Data of this kind can be used as an independent means of estimating time lapse between death and recovery of the victim's remains.

KEYWORDS: forensic science, decomposition, experimentation

In 1978, a research grant, financed by the State of Florida, was awarded by the Florida Board of Regents to the Department of Anthropology at Florida State University in Tallahassee. The project was entitled "A Study to Determine the Time of Death in Criminal Investigations Involving Skeletal Remains." Research, conducted with the cooperation of the Florida Department of Law Enforcement, consisted of burying or placing on the surface of the ground more than 2800 perishable items in various locations and under different environmental conditions. These items were recovered at intervals and their degree of deterioration was measured.

All the experiments were carried out in the field, where for the most part, the variables could be measured but not controlled as in the laboratory. The results obtained are those that one might expect to occur in the field.

Six experiments were conducted. The first, Trenches, was considered the major experiment. The remaining five experiments were considered supporting investigations and were obtained mainly to confirm or elaborate on the results obtained from Experiment 1.

The results of these experiments, covering November 1978 to November 1980, were first presented at the 33rd Annual Meeting of the American Academy of Forensic Sciences in Los Angeles in February 1981. Results covering four years are contained in the *Handbook of Forensic Archaeology and Anthropology*, published in January 1983 [*1*]. The experiments are now completed and the full five years are recorded in this article.

Experiments

1. Trenches.
2. Features—the most perishable items, collected at shorter intervals.
3. Cotton Alone—unbleached and untreated.

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4. Varieties of Cotton.
5. Textiles, with a simulated body (beef bones and hamburger).
6. Two-Year Project—Conducted by Patricia Lasko, specialist in microanalysis.

Experiment 1

In Experiment 1, each trench had ten compartments (see Fig. 1). The materials in each compartment were recovered at intervals of 1, 2, 3, 5, 7, 10, 25, 35, 48, and 60 months. The location of the trenches is shown in Fig. 2.

Each compartment contained fabrics, paper, leather, plastic, and human hair. The fabrics included 102- by 152-mm (4- by 6-in.) swatches of cotton (treated with resin), rayon, triacetate, nylon, cotton/polyester (66.9%/33.1%), and acrylic. Fabric samples in each compartment also included two test strips (Testfabrics, Inc., 55 Vandam St., New York, NY 10013). The fabric combinations in the test strips included acetate (dull)-cellulose, Sef®-modacrylic, Arnel® (bright)-triacetate, bleached cotton, Creslan® 61-acrylic, Dacron® 54-polyester, Dacron 64-polyester, nylon 66, Orlon® 75-acrylic and modacrylic, spun silk,

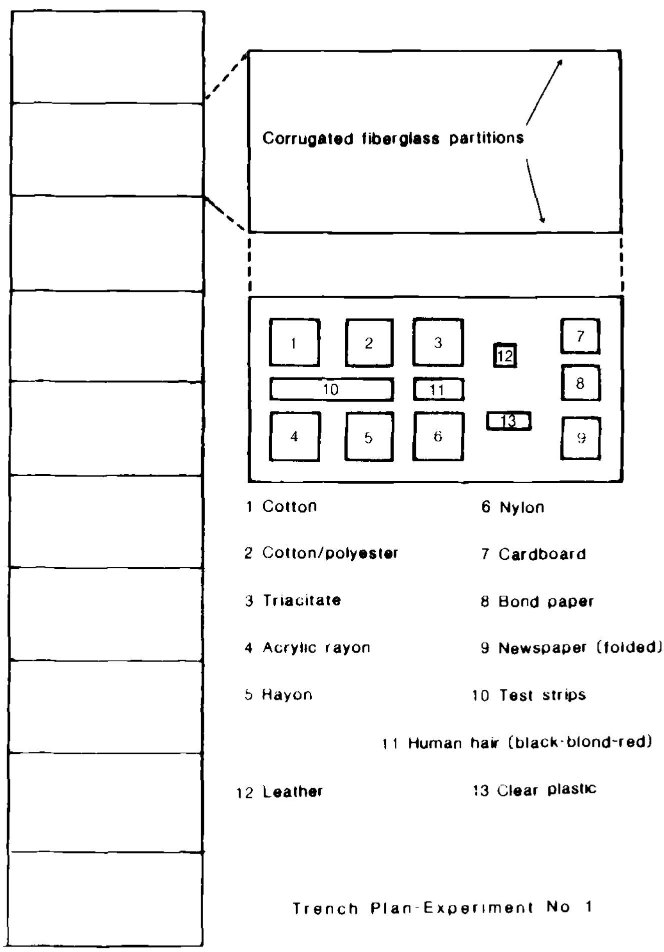

FIG. 1—*Trench plan for Experiment 1.*

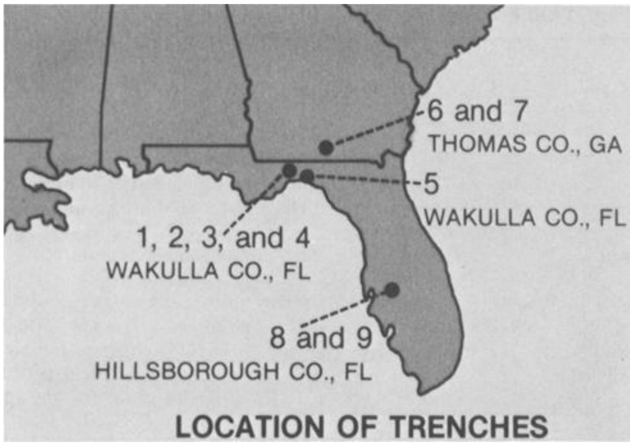

FIG. 2—*Location of trenches.*

Verel® A-modacrylic, viscose-rayon, and wool. The paper samples included a 406-mm (16-in.) square of newspaper folded twice to make a 102-mm (4-in.) square; an ordinary business card; and a half sheet of bond writing paper, folded once. The leather sample was a 25.4-mm (1-in.) square of treated and waterproofed leather of the type used in making the tops of good shoes. The plastic sample was a 25.4- by 51-mm (1- by 2-in.) sheet of polyester, of the type used in wallets. Finally, the human hair samples included blond, black, and red caucasian hair. The items used were selected because they are materials most likely found at a death scene.

Tests used to measure deterioration included visual examination, low- and high-power microscopy, breaking and bursting strength of fabrics, soft X-rays, chemical tests, and scanning electron microscopy. Of these, soft X-rays and chemical tests yielded no useful information. The scanning electron microscope, besides being expensive and time-consuming, also proved to be of little value.

Environmental Variables

Environmental variables included type of soil (Table 1), temperature, sunlight, degree of acidity, contamination (decaying body), type of exposure (surface or burial), depth, moisture, degree of protection, and the presence of insects, plant roots, and caustic materials.

In our experience, temperature was the most critical factor in producing deterioration. This finding applies to materials on the surface and, to a lesser extent, shallow burials. High temperatures greatly accelerate chemical reactions. Microorganisms, capable of destroying many materials, operate best at temperatures above 21.1°C (70°F). A 1958 study [*2*] recorded hourly ground temperatures at various depths over a five-year period. At 0.6 m (2 ft) and below, there was practically no daily fluctuation in ground temperature. At all depths (51 mm up to 3 m [2 in. to 10 ft]), there was a seasonal fluctuation that decreased greatly with increasing depth.

The results in Tables 2 through 6 are for Florida environments, and allowances should be made for temperature differences. It would appear therefore that an estimate of the degree of degradation of associated grave scene material can be useful in establishing the time of deposit. Absolute accuracy is not possible, but a reasonable estimate can be made if the investigator realizes that he or she could be wrong. Using the deterioration rate of more than one item, preferably many, will reduce inaccuracy. To pinpoint the exact time of deposit would be desirable but not necessarily essential for the investigation of a death. In arriving at

TABLE 1—*Soil types of trenches in Experiment 1 [3].*

Trench	Type of Soil	pH	Drainage	Depth, in.[a]	Comments
1	Leon	acid	poor	25	materials buried below pan; test materials below water table 25% of the time
2	Leon	acid	poor	12	materials buried above pan
3	Fresh water swamp "talquin"	acid	poor	11	water is above ground surface 50% of the time; soil is always wet. Muck (decaying vegetable material) to a depth of 13 in., then sand.
4	Leon	acid	poor	surface	no shade; sunlight
5	"Chipley" sand and clam shells	alkaline	fair to good	12	no top soil, just sand and shell. This area was a prehistoric Indian site. The clam shells were discarded by the Indians, which accounts for the alkaline soil reaction.
6	lakeland	acid	good	12	sand mixed with small amount of clay located near lake.
7	orangeberg	acid	fair to good	12	mixture of clay and sand on knoll
8	Leon?	acid	poor	12	Top 3 in. is pasture sod; next 9 in. is sand and muck. Hard pan is at 12-in. depth; test materials on hard pan under water part of the time.
9	lakeland	acid	good	12	all sand; pasture sod on top

[a] 1 in. = 25.4 mm.

an estimate of the time lapse between deposit and recovery, a minimum and maximum span should be considered. This estimate could then be used by the investigator in setting priorities in such matters as checking missing person lists, distributing information to law officials in other communities, and so on.

The sequence of deterioration of the materials used in our studies is as follows: rayon, paper, untreated cotton, treated cotton, silk and wool, human hair, cotton/polyester, triacetate, nylon, leather, plastics, and, acrylic.

Summary

The results of a series of experiments designed to determine the relative durability of common death-scene materials are reported. Of the variables considered, temperature (in Florida) appears to be the most critical. Data of this kind should be of value as an independent measure of time lapse between death and recovery of human skeletonized remains.

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TABLE 2—*Deterioration of cloth.*[a,b]

Trench Number	Exposure Time, months										
	1	2	3	5	7	10	15	25	35	48	60
					RAYON (M 7032)						
1	Sv	Sv	T	Sv	T	T	T	T	T	T	...
2	Sv	Sv	Sv	T	T	T	T	T	T	T	...
3	T	T	T	T	T	T	T	T	T	T	...
4	Mi	Mi	Mo	Mo	Sv	Sv	Sv	T	T	T	...
5	Mi	Sv	Sv	Sv	T	T	T	T	T	T	...
6	Sv	Sv	Sv	T	T	T	T	T	T	T	...
7	Sv	Sv	T	T	T	T	T	T	T	T	...
8	Sv	T	T	T	T	T	T	T	T	T	...
9	X	Sv	T	T	T	T	T	T	T	T	...
					COTTON (M 7031)						
1	none	none	none	none	Mi	Mo	Sv	T	T	T	...
2	none	none	none	Mi	Sv	T	T[c]	T	T	T	...
3	none	none	Mi	Sv	Mo	T	T	T	T	T	...
4	none	none	none	none	none	Mi	Sv	Sv	Sv	T	...
5	none	Mi	Mi	Mi	Sv	Sv	T	T	T	T	...
6	none	none	Mi	Sv	Sv	T	T	T[c]	T	T	...
7	none	none	Mi	Sv	Sv	T	T[c]	T	T	T	...
8	none	Sv	Sv	Sv	T	T	T	T	T	T	...
9	none	none	none	none	Sv	Sv	Sv	Sv	T[c]	T	...
					TRIACETATE (M 7027)						
1	none	none	none	none	none	none	none	none	Mi	Mi	Mi
2	none	none	none	none	none[d]	none	none[d]	Mi	none	none	Sv
3	none	none	none	Mi	none[d]	none	none	Mi	none	none	Mi
4	none	none	none	none	none	none	Mi	Mi	Mo	T[c]	T
5	none	none	none	none	none	none	none	none	none	Mi	Sv
6	none	none	none	none	none	none	none	Mi	none	none	...
7	none	none	none	none	none[d]	none[d]	none[d]	none	none	none[d]	...
8	none	none	none	none	Mi?	none	Mi[d]	none[d]	none	none	...
9	none	none	none	none	none	none	Mi[d]	Mi[d]	none	none	...
					COTTON/POLYESTER (M 7073)						
1	none	none	none	none	none	Mi	Mi	Mo	Sv	Sv	Sv
2	none	none	none	none	none	Mi	none	Sv	Sv	Sv	Sv
3	none	none	none	none	none	Mi	Mi	Mi	Sv	T[c]	T[c]
4	none	none	none	none	none	Mi	Sv	Mo	Sv	Sv	Sv
5	none	none	none	none	none	none?	Mi	Mo	Sv	Sv	T[c]
6	none	none	none	none	none	none	X	Sv	Sv	Sv	...
7	none	none	none	none	none	Mi[d]	Mi	Mi	Sv	Mo	...
8	none	none	none	none	Mi	Mi[d]	none	Mi	Mo	Mo	...
9	none	none	none	none	none	Mi	Mi	Mi	Sv	Sv	...
					NYLON (M 7028)						
1	none	none	none	none	none	none	none	none	none	none	none
2	none	none	none	none	none	none	none	none[d]	none	none	Mi
3	none	none	none	none	none	none	none	none	none	Mi	Mi
4	none	none	none	none	none	Mi	Sv	Sv	T[c]	T	T
5	none	none	none	none	none	none	none	none	none	none	none
6	none	none	none	none	none	none[d]	none	none	none	none	...
7	none	none	none	none	none	none[d]	Mi	none	none	Mi[d]	...
8	none	none	none	none	none	none[d]	Mi	Mi	none	none	...
9	none	none	none	none	none	none[d]	Mi[d]	none	none	none	...

[a] Mi = mild damage; less than 5% destroyed. Mo = moderate; 5-25% destroyed. Sv = severe; 25-90% destroyed. T = total; more than 90% destroyed. X = not recovered.

[b] Acrylic (M 7033) sustained no damage in any trenches through 60 months of exposure.

[c] A few scraps; less than 2% remaining. Could be considered uncollectible.

[d] No damage to fibers; root holes present.

TABLE 3—*Deterioration of cloth in test strips.*[a]

Trench Number	Exposure Time, months											
	1	2	3	5	7	10	15	25	35	48	60	100
						BLEACHED COTTON[b]						
1	0	5	0	5	5	90	30	100	100	100	...	...
2	0	5	20	25	50	99	100	100	100	100	...	...
3	5	25	30	99	100	100	100	100	100	100	...	...
4	0	0	0	0	...	95	50	90	75	99	...	...
5	50	60	80	100	100	100	100	100	100	100	...	...
6	0	0	0	90	100	100	98	100	100	100	...	...
7	0	10	10	80	90	100	100	100	100	100	...	...
8	0	75	75	50	99	100	65	99	100	100	...	...
9	0	5	5	85	95	100	100	90	100	100	...	...
						VISCOSE-RAYON[c]						
1	15	5	25	75	90	100	95	100	100	...	...	100
2	0	5	60	99	100	100	100	100	100	...	...	100
3	75	50	75	90	100	100	100	100	100	...	...	100
4	0	0	0	0	...	95	100	95	100	...	...	100
5	90	100	100	100	100	100	100	100	100	...	...	100
6	0	20	30	80	100	100	100	100	100	...	...	100
7	5	50	50	90	95	100	100	100	100	...	...	100
8	0	100	90	90	100	100	90	100	100	...	...	100
9	0	5	100	100	100	100	100	100	100	...	...	100
						SPUN SILK[c]						
1	0	0	0	0	0	0	0	85	80	85	95	...
2	0	0	0	0	0	20	15	100	100	100	100	...
3	0	0	0	0	5	0	0	25	50	100	100	...
4	0	0	0	0	...	35	20	60	96	100	100	...
5	0	0	0	15	85	45	40	100	100	100	100	...
6	0	0	0	0	0	75	95	100	100	100	...	...
7	0	0	0	0	5	40	80	100	100	100	...	...
8	0	0	0	10	0	90	30	98	100	100	...	...
9	0	0	0	15	10	55	95	100	100	100	...	...
						WOOL[b]						
1	0	0	0	0	0	0	5	5	75	95	100	...
2	0	0	0	0	0	35	30	99	100	100	100	...
3	0	0	0	0	35	35	30	50	70	100	100	...
4	0	0	0	0	...	10	30	50	98	100	100	...
5	0	0	0	20	40	25	95	100	100	100	100	...
6	0	0	0	0	5	70	95	100	100	100	...	...
7	0	0	0	0	30	50	95	100	100	100	...	...
8	0	0	5	0	0	5	0	90	100	98	...	...
9	0	0	5	0	15	60	95	99	100	100	...	...

[a] The remaining nine fabrics on the test strip were acetate, Sef (modacrylic), Arnel (triacetate), Creslan 61 (acrylic), Dacron 54 (polyester), Dacron 64 (polyester), nylon 66, Orlon (acrylic and modacrylic), and Verel A (modacrylic). All these, buried, showed no deterioration at 48 months, with the following exceptions: Trench 5: acetate, 2% and Trench 6: acetate, 2%; triacetate, 1%. On the surface (Trench 4) there was 80% destruction of acetate, 100% of triacetate, and 75% of nylon. At 60 months, for buried samples, deterioration was demonstrated in Trench 5: acetate, 10% and Trench 3: acetate, 5% and triacetate, 1%. On the surface (Trench 4): acetate, 95%; triacetate, 100%; nylon, 95%, Dacron 54, 15%; and Dacron 64, 25%.

[b] Deterioration expressed as percentage of fabric destroyed.

[c] Deterioration expressed as percentage of fabric gone.

TABLE 4—*Breaking strength (1-in. cut strip test).*[a]

Trench Number	1 W	1 F	2 W	2 F	3 W	3 F	5 W	5 F	7 W	7 F	10 W	10 F	15 W	15 F	25 W	25 F	35 W	35 F	60 W	60 F
COTTON TREATED WITH RESIN, 100% (M 7031)[b]																				
1	23.4	17.8	16	10	11.8	7.5	11.1	6.1	7.8	0.2	X									
2	19.3	25.6	15.5	7	15.1	5.4	X	6.4	X		X									
3	8.7	10.9	7	5.4	8.6	2.5	X		X		X									
4	43.0	22.8	37.2	28.7	28.4	22.5	37.0	17.4	not collected		X									
5	6.6	2.8	3.3	1.4	3.6	3.0	2.4	1.9	X		X									
6	30.2	19.1	2.8	1.5	0.6	0.3	X		X		X									
7	24.4	9.7	7.4	4.0	13.0	4.4	X		X		X									
8	11.6	5.9	termites		termites		X		X		X									
9	25.7	16.0	22.8	16	12.5	15.7	...	2.2	X		X									
TRIACETATE (M 7027)[c]																				
1	29.7	22	31.6	21.8	28.6	20.6	29.7	23	27.6	19	34.4	14.5	35.9	19.8	37.5	19.9	24.3	18.0	19.7	8.5
2	28	16.2	29.6	21.2	28	19.2	33.7	21.7	24.8	20.6	32.6	18	30	18.4	20.9	15.3	29.1	19.8	X	
3	31.2	10.8	29.4	12.4	36.2	17	28.9	16	26.6	13.5	31.3	12	29.1	14.3	30.3	22.6	36.2	17.6	28.9	17.0
4	34.4	21	28.7	15.6	28.6	8.4	25.5	15.2	not collected		4.8	3.4	14.6	4.3	17.1	20.6	X		X	
5	28.5	12.5	34.8	19.0	30.9	20.8	16.3	15.8	17	6	20	11.8	32.1	12.8	18.8	12.7	25.9	15.2	X	
6	33	22.4	33.2	20.6	31	20.4	33.4	23.5	30.4	16	26.4	21.5	33.1	15.6	29.2	21.3	32.4	20.7		
7	32.8	20.4	35.6	22.2	30.5	19.0	26.6	23	25.2	20.8	30.9	14	26.1	16.1	37.1	20.5	23.8	18.0		
8	36.2	22.2	30.7	20.6	30.9	18.6	30	22.2	29.1	19.0	27.8	19	17.8	17.8	38.1	21.6	30.1	17.7		
9	30.8	22.8	31.5	18.2	35	18.2	30	23	31.7	12.6	28.7	21	27.5	17.6	39	22	38.4	21.1		
NYLON (M 7028)[d]																				
1	43	41	42.5	28.0	57	30	46	45.4	51	33.0	51	35	49.4	42.6	51.4	39.7	47.1	28.5	34.7	24.4
2	54.5	27	44	33	57	45	51	36	41	34	36	25	25.2	23.4	33.8	26.5	33.7	23.3	28.5	26.8
3	50	40	46	48	54	25	50	46	56	29	51	34	40.3	40.7	50	30.7	30.3	26.5	17.5	22.0
4	50	42	45	28	50	25.5	43	23.5	not collected		18	3.0	4	2	X		X		X	
5	58	33	46	35	52	44	54	24	52	24	46	38	48.2	42.3	47.6	42.8	51.6	32.5	43.8	39.6
6	51	32	50	34	56	36	47	48	53	28	44.5	30	39.9	29.3	43.6	39.2	20.4	31	...	
7	48	36	43	30	45	29	46	38	35	34	43.5	27	32.8	29	42.3	34.3	34.8	25.7	...	
8	48	51	49.5	25	44	28	49	42	43	30	44	43	35.9	42.6	33.3	33.4	48.8	33.7	...	
9	56	46	50	33	51	41			55	35	51	34	48.8	34	48.5	37.9	34.5	28.7	...	

[a] W = warp; F = fill; X = insufficient material. The results are expressed in pounds per inch. Only one or two specimens were used for each test depending on how much fabric was available.
[b] Control: W = 35; F = 25. [c] Control: W = 38; F = 24.5. [d] Control: W = 58.5; F = 47.

TABLE 5—*Bursting strength.*[a]

Trench Number	Exposure Time, months: 1		2		3		5		7		10		15		25		35		60	
	Face	Back	Face	Back	Face	Back	Face	Back	Face	Back	Face	Back	Face	Back	Face	Back	Face	Back	Face	Back
	KNITTED ACRYLIC (M 7033)[b]																			
1	68	71.5	7.15	84.5	80.5	87	77.5	77	87.5	76	71	71	63	81.5	71.5	74.5	63	78	77	85
2	80.5	78.5	81.5	80	81.5	94	85	88	82	77.5	84	84	74.5	70	not collected		69	78	85	82
3	81.5	83.5	79.5	76.5	74.5	73	68	86.5	no acrylic		78	77	63.5	75	94	90.5	78	81	74	75
4	73.5	76	63.5	82.5	73.5	79.5	72.5	75	not collected		74	67	82.5	76.5	79.5	65.5	44	52	49	52
5	80	80	66.5	62	83	74.5	84.5	79.5	75	76.5	69	71	83	74	73.5	77.5	76	73	77	76
6	90	87	82.5	83	81	78	77	79	71	72	79	80	93.5	75.5	80.5	75	91	79	...	
7	74.5	75.5	78.5	78.5	75	75	70.5	86	73.5	72	78	74	88	89	88	80	89	88	...	
8	78	80	75.5	79	78	66.5	71.5	74	83.5	78.5	74	73	73.5	71	76	76.5	72	75	...	
9	84	77.5	no acrylic		74	71	70	75	79.8	81.7	66	74	69	62.5	74.5	75.5	85	89	...	
	KNITTED COTTON/POLYESTER 66.9%/33.1% (M 7030)[c]																			
1	60	52	88.5	84.5	77	75.5	88	82	66	77	31	33	26	31.5	10.5	15	X		...	
2	80.5	79	86.5	65	84	79	78	78	61	57.5	59	64	21	26	17.5	13	X		...	
3	84	90.5	82	83	58.5	47.5	72	63	74	60	32	45	16.5	11.5	13	15	X		...	
4	87	84.5	74	81.5	80	82	78.5	79.5	not collected		27	27	32	38.5	11	10.5	X		...	
5	86	84.5	85	81.5	74.5	71.5	25	30.5	26.5	34	17	23	18.5	7	10.5	10.5	X		...	
6	86.5	80	59.5	68	59	59.5	55.5	66	54.5	50	29	34	not collected		X		X		...	
7	85.5	80	78.5	74	56.5	66	84.5	85.5	73	67	37	50	19.5	21.5	28	20.5	22	14.5	...	
8	63	68	49	48	75	60.5	52	43	35.5	47	61	55	56.5	30	60	41	X		...	
9	39	46	75	69.5	53	69.5	54	52	31	47.5	20	18	14.5	11.5	9.5	10.5	X		...	

[a] X = insufficient information. The results are expressed in pounds per square inch.
[b] Control: face = 92, back = 91.
[c] Control: face = 83, back = 82.

TABLE 6—*Expected minimal exposure of death scene materials (in months).*[a]

Material	Acid Buried (T-1-2-6-7-8-9)	Alkaline (T-5)	Freshwater Swamp (T-3)	Surface (T-4)
Rayon	1	2	1	5
Paper	5	1	1	5
Cotton (treated)	10	7	5	15
Silk	15	7	25	10
Wool	15	5	7	15
Cotton/ polyester	25	25	35	15
Nylon	X[b]	X	X	15
Triacetate	60	X	X	35
Acrylic	X	X	X	X
Leather	X	X	X	35
Plastic	X	X	X	X

[a] If a recovered item is intact and is in relatively good condition, one may assume that the chances are that the item could not have been exposed much longer than the length of time shown. See proceeding tables for further information on cloth deterioration.

[b] X = material was in good condition after 60 months; needs more observation.

References

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